Getting through difficult projects

A grounded theory of engineers' competence frontiers

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Table of contents

List of Figures

Abstract

Engineers often become emotionally involved in their projects, experiencing them as exciting and satisfying, with times of intense frustration and anxiety. Previous research has not focused on this emotional involvement despite its centrality to engineers' experiences. This study explored engineers' experiences of being involved in difficult projects, that is, projects they find stressful or have difficulty coping with, and developed substantive theory on how they cope with such projects. The study used the Grounded Theory method, which is concerned with understanding people's concerns and how they go about resolving those concerns.

The primary source of data was in-depth interviews with thirty-nine people, mainly civil engineers, from throughout New Zealand. Additional data included project documentation collated following the collapse of the Opuha Dam, and books about the past Ministry of Works (New Zealand).

The common concern of engineers is centered on the inter-relationships between their projects and their competence frontiers. Each engineer has a competence frontier, which is the self-image of the extent of his or her competence. Difficult projects provide engineers with the opportunity to advance their competence frontiers, however, there is greater risk of being, or being seen to be, incompetent. Engineers cope with this concern by assessing whether they have done a good job and adjusting the extent to which they take ownership of their projects, while concurrently tackling the project tasks. These processes affect the nature of engineers' emotional involvement with projects, which then feeds back to influence those processes in a complex web of interactions.

The study provides an interpretive understanding of the relationships between engineers and their projects, and why they find some projects difficult. It highlights the importance of engineers having projects of appropriate difficulty with good social support and a culture that supports realistic attributions of the factors that affect performance.

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The process of undertaking postgraduate research involves considerable time, emotional commitment, and personal learning at a range of different levels. One of those levels for me was learning about economic poverty and its consequences. My son, Cairn, got pneumonia probably in part due to getting too cold. Cairn's pain sticks in my memory. The financial support I received soon after this, from the Department of Management, helped to warm the house and the heart – it was great to have the sense that I was believed to be worthy of support!

It took me some time to decide to do a grounded theory, requiring a shift from my technical engineering focus to a social research focus. During this time I had many meetings with Professor David Elms where we struggled to find a research topic and research method that we could both see through to the end. Eventually grounded theory was chosen as the research method, necessitating supervisors experienced in qualitative research. I have considerable gratitude for David's efforts and particularly his help in developing my conceptual abilities that are so important to doing grounded theory, David, thank you. During my time in the Civil Engineering Department I also received encouragement and support from Dr David Wareham, Dr Mark Milke, Lousie Fitzgibbon, Leigh Newport and the late Professor David Wilkinson.

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Chapter 1
Introduction

1.1 Difficult projects in New Zealand

Civil engineers are important to the safety and health of public and private infrastructure, and the performance of projects in terms of budget and time. Many projects, however, present challenges to engineers' competence, certainly in New Zealand[1], where the present study is based. Civil engineering has a long history in New Zealand, with the first engineering school established in 1888 (Newnham, 1971) and the first engineering institute in 1912 (Hansen and Hall, 1993). This history has helped to enhance engineers' competence. New Zealand is, however, a small country with limited financial resources, and climates and geological conditions that often present challenges to engineers. Challenges to engineers' competence also arise from population increases that place additional demands on infrastructure, and higher expectations of safety and the need to minimize environmental effects. Further, in recent decades engineers have had to adjust to changes in the ways projects are undertaken, with greater need for public consultation, the use of computers, and the use of performance based rather than just prescriptive legislation. Many civil engineering graduates began their careers with the New Zealand Ministry of Works (MoW) prior to its demise in 1987. The MoW had well-defined graduate development programmes with considerable levels of mentoring and supervision. The commercialisation of MoW resulted in less mentoring of graduates by senior engineers and required that graduates became productive much more rapidly. Many graduates currently feel very "thrown in the deep end" when they enter engineering practice. The introduction of quality systems has also contributed to the considerable emphasis being placed on engineers to perform their work efficiently. Many New

[1] New Zealand (also known as 'Aotearoa') comprises two main islands and other smaller islands with a total land area a little larger than the United Kingdom. It is situated in the southwest Pacific on the 'Pacific-Rim-of-Fire'. New Zealand was originally inhabited about 1000 years ago by people from the South Pacific. They built villages and developed protocols regarding disposal of human waste, and can therefore be considered as New Zealand's first civil engineers. Significant immigration of people from the United Kingdom, Europe, and China occurred from 1840. Large-scale infrastructure such as lighthouses, wharves and railways occurred from this time. New Zealand is currently a developed country with a population of 3.9 million.

Zealand engineers regularly face technical issues in their work that they have had little or no specific training for during their tertiary education. Thus they need to learn-on-the-job. Considerable portions of engineers' work involves the management of their projects, yet few enter the engineering workforce with many project management skills. Indeed, most civil engineering projects in New Zealand involve only a small number of engineers, perhaps only one, and most engineers quickly become managers of the projects they are involved with. This means that engineers' competence is usually assumed to be reflected in the performance of their projects, so when projects perform poorly engineers can find it difficult to cope. In summary, it is a characteristic of New Zealand civil engineering that engineers are often faced with difficult projects that challenge their competence.

I finished my civil engineering degree in 1991, and then had the opportunity to work on a difficult project, which involved the disposal of sewage sludge that had accumulated in a sewage treatment plant. The problems presented by the project required an unprecedented solution. This presented challenges to many of the people involved in the project, including not only myself and my supervising engineers, but also the contractors, the engineer who assessed the resource consent application, and the client's representative. I had been interested in environmental issues for a number of years, and wanted to ensure that this project would be environmentally sound despite my lack of knowledge in the technical field. I found this difficult to achieve. This project initiated my interest in how civil engineers cope practically and psychologically with difficult projects, which led to the present study. During the present study, the concept of 'difficult projects' became defined as those projects that tax or exceed individual engineers' abilities to cope, whether those abilities are in coping technically, managerially or emotionally. So both projects that are technically or managerially challenging, and those that engineers find stressful to be involved with, are difficult projects.

There is an absence of research focusing on why engineers find projects difficult, and what processes are involved in coping with them. The Grounded Theory research method (Glaser and Strauss, 1967b; Glaser, 1978; Glaser, 1992; Glaser, 1998) is

particularly applicable to areas where there is a substantial lack of existing research and was therefore used for the present study. The method involves beginning a study without hypotheses and inductively developing an understanding of the processes that are going on. Accordingly, the research involved in-depth interviews in New Zealand with thirty-nine people, mainly civil engineers. In addition, the study involved analyzing documentation from the Opuha Dam collapse in 1997 (see Boyle (1998)) and the books about the past New Zealand Ministry of Works by Norman (1997) and Ponder (1996).

In the present study engineers' main concern with difficult projects was the potential or actual effects of project involvement on their 'competence frontiers'. The concept of a competence frontier was developed in this study. Engineers each have a competence frontier, which is their self-image of the extent of their competence. In this study the term competence means whatever competence is demanded by the project, be that of a technical, managerial or emotional nature. Difficult projects provide engineers with the opportunity to advance their competence frontiers, however, with such projects there is greater risk of being, or being seen to be, incompetent. The present study focused on engineers' processing of their competence frontiers in the context of project involvement, rather than in broader contexts such as their career planning.

The focus on this study is on people undertaking work of a civil engineering nature, rather than all types of engineering. This focus has provided a particular view of engineers' competence frontiers, influenced by the nature of civil engineering, such as the high need for public consultation, the public visibility of many projects and the small number of engineers working on most projects. The theory of engineers competence frontiers presented here is likely to apply, with modification, to types of engineering other than civil. This is consistent with generalisability of many grounded theory studies. During this thesis I have usually referred to engineers rather than civil engineers. It is anticipated that readers who are engineers of non-civil engineering disciplines will usually have a feel for the extent to which a part of the theory applies to their own particular discipline, or work situation.

1.2 The processes of coping with difficult projects

The present study identified three concurrent processes that occur as engineers go about coping with their concerns with difficult projects. These processes are called "*getting through the project*" or *frontier building;* "*have I done a good job?*" or *frontier positioning;* and "*taking ownership*" or *connecting-project-and-frontier.* A summary of these processes is presented, below, by the story of a hypothetical engineer that I constructed in order to give engineers feedback from the study. This hypothetical engineer is presented as having had the experiences of the engineers I interviewed, and as having developed an understanding of the processes that are involved in coping with difficult projects. As such, the story of this engineer incorporates phrases and excerpts from quotes in the thesis[2], and discussion of how engineers can cope with difficult projects. The story is written from an older, experienced engineer's viewpoint, whilst also relating experiences from younger days. Although the story is presented in a narrative style, the concepts and structure of the theory developed in the present study underlie the story.

Difficult projects are projects that challenge me, that push me to gain new competencies. And it's not just the technical skills that are important, it's the total package, because it is no good being technically brilliant if I'm not able to communicate and remain calm when things do get sticky.

I usually like difficult and challenging projects because they are always the most interesting, and they provide me with the opportunity to enhance my competence, which gives me personal satisfaction. There are also financial rewards associated with enhancing my competence. I would be a bit disappointed within myself, looking forward, if I didn't continue to make some efforts to try and do things better. It is almost like a little bit of a zest for learning I think: and difficult projects provide plenty of learning opportunities, you know, being thrown in the deep end is a way that I really do grow.

It is important not to work outside one's area of expertise though. Civil engineering projects usually have the potential to have significant impacts, like if we get this wrong the consequences could be fatal! Come the end of the day, if I'm asked for my professional opinion, either I have the ability to give it or I haven't, and if I haven't I'll say, 'no sorry, that's outside my expertise'. With difficult projects though, I feel that I'm working at the edge of my ability, whether technical or otherwise, and in

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[2] In the story I have not indicated where quotes begin and end. Often phrases from several different interviews have been incorporated into one sentence. Some quotes have been altered, such as the tense being changed from third person to first person. Most of the quotes used in the story are presented elsewhere in the thesis.

some projects I feel that I may well be organising a disaster for myself somewhere further down the track. So the problem with difficult projects is that I'm working with 'borderline competence', hence there is a risk that I'll be incompetent and that could have adverse consequences for my career, no less for the people or the environment that might be affected by the project.

With civil engineering projects, while there may be some codes or standard procedures I can use there is often nothing I can rigidly apply. So while systematic procedures, or standard numerical models may be essential ingredients for a successful project they are not in themselves sufficient to ensure success. This means that as engineers we do usually have a reasonable level of ability to influence the shape of the project. The 'shape of the project' can include both the content of the project (such as its design, contractual documents and resource consent conditions), and the process of the project (such as whether it is to budget, on time and up to specifications, and who works on the project). The trouble is that projects often go out-of-shape. There are such a diverse number of ways that projects can go out-of-shape that it regularly happens. I'm not likely to be able to reach the stage where I can cover all project problems and swim on quite happily.

It can be quite hard to get started on a difficult project. It's a bit daunting, like can I actually do this? So I'll often start by doing the things I know most about. Tackling a difficult project involves fitting the expertise of both myself and other people (including things like engineering codes) to the particular problems presented by that project. This means that being able to access expertise is really important. I tend to find that if I know there are other people I can ask for help it makes it much easier: I have got someone to bounce ideas off, someone to check that I am heading in the right direction.

A big thing now is also getting the public acceptance for the project. I can't provide a solution in an ivory tower, just sitting down with a technical box and doing my own thing. I would come up with something but it may be miles away from being of any use to anyone out there. So I'm constantly out there, trying to see the problem through other peoples' eyes, tailoring my investigations to answer the questions that are being raised. There is often no one right answer, instead it is a matter of finding the one that will be acceptable, that will get the thumbs up. Of course there are lots of other people and organisations in addition to the public whose approval I need for the project: the client, the consent authority, peer reviewers and so on.

In the process of being involved in a difficult project there is a lot of information that can be used to interpret how the project is performing, and of course how I am performing. I will be trying to assess whether I have done a good job. I am concerned with making sure the project is up to standard and will get the thumbs up, and I am also concerned with whether I am being competent and whether I am improving my competencies. Other people are also assessing both the project performance and my competence so I usually take on board any of their opinions that I receive on these matters. At first I used to take the project performance really personally and my confidence was dependent on other people's reactions. So if I felt the client was happy with what I was doing and was happy with the price and we

were achieving it within the program that was set, then I'd feel quite confident about the project and about my performance. More negatively, there were times when my boss had indicated that I hadn't performed well on two or three projects that didn't happen to be going really well at the time, and then I felt like I shouldn't be doing engineering after all!

The performance of the project is usually assumed to reflect my performance and hence my competence. Sometimes that is good: if I have got a project that is running well, I get quite a buzz from it. I think I look good, it is running to budget, I'm going to meet the deadlines, I'm going to end up with a client who is happy with what they have got at the end and I get a buzz from that. And I know darn well that other people may look up to me because of it.

There can be quite a bit of hearsay going on about the project and my performance. For example, my boss judges my competence by how many problems my work is creating and if the client is happy with the work I am producing. And peers in the office judge my competence by the feedback they are getting from the contractors. But the scary thing is what people say behind your back. So I try to tune in to what feedback I can about the project's performance and my performance.

There is a problem in that a lot of people don't understand how little control we engineers have over many of our projects. They expect problems to be black and white and easy to fix but they often aren't. Lay-people in particular often don't seem to understand us, e.g.: 'it doesn't work as well as you said it would', so we have to say 'no, it doesn't, so we'll have to change this and this etc'. You never, ever hear an engineer stand up and say, 'I guarantee this will fix the problem'. We say things like, 'this will reduce the seriousness or frequency of the problem'. Engineers are always trying to battle with nature and have a healthy respect for what it can do.

This lack of understanding can be really difficult to cope with emotionally, it can be really frustrating. I've got this council asset that I manage and if anything goes wrong with that job I'm under pressure. My name is in the paper, my face is in the paper, and wherever I go people ask me, 'what the hell is wrong with that project?'. They'll even stop my spouse in the street!

It's interesting though, because even in an organisation with lots of engineers, like an engineering consultancy, there can be a culture of high performance expectations that are based on the project's performance, and I can feel that the lack of control I have may not be adequately recognised. Those high expectations can give me a feeling that I will be letting the side down if I don't produce work of a certain quality that is within the budget and programme. For example, I once worked for a company who really expected a lot and everyone took themselves very seriously. While that had some benefits in that I aimed very high, I also tended to feel that I wasn't meeting the expectations of the company and that really started affecting my confidence. I had this project that was perceived as a little project, but the client kept coming back with changes, and there were lots of things that I had thought initially would be straight forward but weren't, and I wasn't actually a specialised engineer for that type of work so I was just a bit unfamiliar with the design side of things as well, so it

took me probably thirty percent longer just to actually go through the design than it would for an experienced person. I felt really annoyed that I wasn't performing better on that project that really was a tiny little piece of work. But as I've explained there actually were quite a few reasons why it was taking me longer than expected.

I have found that in some engineering work places there is a culture that does recognise the lack of control each engineer has over their project's performance, in which case engineers' performance is assessed more on whether they follow the appropriate procedures. So people whom I'm working with will look largely at the process that is going on, say if I talk to them about the right issue at the right time, or have I ignored their input, or I have missed this constraint or that particular issue.

I still have to know what the appropriate procedures are though. I realised after I first came into one job, that I basically ignored all of the standard employer processes and just planned the project, and figured out what I thought was necessary. I stood on a few toes, and pissed a few people off, but I ended up getting it done. But now I comply a little more. I guess it is a matter of drawing the fine line between if I want my work-mates to believe me to be competent and successful and therefore choose to work with me, or whether they think I'm, ah, I don't know, a bully or ignoramus or stupid and choose not to.

When I'm not too sure how competent I've been with a project, I reflect on the project a lot and stay tuned in to what is happening with it after I have handed it on. Whereas projects that have been very routine and I have been very confident with I hardly think about. The more difficult ones I go over because I'm trying to find out if I have made any mistakes.

What I have learnt about this problem of how the project implicates my competence, is to think about all the factors that are influencing the project's performance. Because often the contributing factors are not completely within my control, for example, unforeseen problems often arise. The bonus in trying to recognise and think about these factors is that, not only do I realise what is not my own fault, I also learn about what I can try to influence in the future. Often though, it's hard to tell whether it's one factor or another that caused the project to be performing poorly, that is, to get out-of-shape. The thing is to try to influence as many factors as I can, but not to get too stressed if I can't influence them all.

*It can also be useful to ask other people's opinions about what factors they think are influencing the project. Like sometimes I'll talk about the odd thing with my supervisor if something's going wrong, something has happened. 'How do we get this to go right?', 'That guy's f***ing it up, or am I wrong, have I got it wrong?' Sometimes I have to be careful not to take on board too much criticism though, like sometimes people will tell me that they don't think I'm doing a good job, but I know I am doing a good job.*

How well the project is performing and how this reflects on my competence can influence how personally connected I feel to the project, that is, to what extent I take ownership of the project. With some projects I feel that I am a part of the project, it

is very much my project. When I become involved in a project I start thinking about whether it's going to enhance my competence, whether it will be good to have on my CV. I'm trying to anticipate how important the project will be to me, which influences how much ownership of the project I feel. How well the project is performing impacts on other people as well as me, so I also think about how the project might affect others.

And of course what the consequences of my performance and the project will actually be, and what I expect to be able to do about those consequences depends on a whole range of factors. Like whether I have got relevant experience, or can find someone with such experience, whether I can allocate enough time and resources to the project, how well the project has been set up, what the public perceptions of the project are, what level of responsibility I've got, whether the project is important to the career direction I want to head in, how many problems arise, and so on.

So how much ownership I take of the project depends on my assessment of how the project is going to influence me, and how I might be able to influence the project and what the consequences of the performance (or failure) of the project could be. This assessment then influences the extent to which I strive to influence the project. You see projects often work because people do contribute beyond the formal boundaries of their role. So people's ownership of a project is not usually exactly the same as their formal responsibility.

Sometimes when projects are going well then people can strive to have greater influence on those projects, especially if they think it will make them look good. The interesting thing is that when I got a major stuff-up in one particular project, everybody dived for cover. There was a feeling that, 'thank God somebody is sort of dealing with it now, yes we knew there was a problem, oh I always suspected there was a problem, but that is fine, you are dealing with it now, I can walk away from it and leave you to it'.

Sometimes I actually want to get other people to either increase or decrease their ownership of the project, because the level of ownership other people take can influence the potential consequences (for myself and others affected by the project) and hence my own level of ownership. Once I was trying to get this person to increase his ownership by making him aware of the problems and the risks he was taking. But he couldn't face it, he disappeared, he was back in the office hoping.

When I'm reflecting on whether or not I have done a good job, and how the project is performing, I'm basically working out whether or not things are going the way I want them to. And when I'm trying to anticipate the consequences I'm trying to work out whether it's important, whether it matters. These two things then affect the specific emotions that I feel. So when I become involved in a new project that I think will improve my competence I get quite excited about it, wondering what it is like, wondering if it is going to be difficult and whether I am going to be able to do the work properly.

Hopefully the project does go well and the satisfaction just builds. The intensity of satisfaction depends on how important I think the project is, to me and to others, and whether the project is going the way I want it to. It can be a good feeling seeing the project in three dimensions, where I see people using it that way I intended it to work: 'it looks great eh!'. There are projects that my kids will be able to take their kids to and say 'your grandparent was in charge of that'. If my children see a project I've worked on they ask, 'you were in charge of that weren't you?', and I say, 'yes'.

Unfortunately projects often don't go the way I want them to, and if I don't feel like I've got control of the situation I can feel really frustrated. On some jobs if they are losing money, they are bastards, you know, no matter what I do they are still going to lose money. My lack of control might come from the way the project was set up before I become involved, if I need to get information from other people and they don't supply, or if other people aren't doing their work properly. There was this project where I wasn't involved at the start so it was pretty much dumped on me to do. Then the person who was the project manager resigned, so then we had two people doing the job having come in half way through. We had a meeting with the client to discuss the draft report that we'd presented to them and it eventuated that what we'd given them wasn't actually quite what they'd wanted. Pretty silly, it made us look pretty silly, it was quite frustrating, highly aggravating really.

When I am uncertain of my ability to cope with a challenging situation presented by a difficult project I can have quite a strong fear of failure. I can be a bit nervous about whether I can do it, I'm anxious, it's a bit scary. It is a fear of not being able to solve the problem and do what is expected of me, basically to do the project. A consequence of fear of failure is that it makes me more likely to procrastinate. It's easy to put aside a difficult project or problem, especially when I'm already busy because then it is very easy to justify doing the straight-forward projects instead of tackling the difficult one. Sometimes it actually pays to procrastinate, though, like if I feel that things are a bit in the balance or I'm not quite convinced that I have got enough evidence to go down a certain path. Invariably with a bit more time I can do a bit more reading or talk to someone else to get information to help make the decision I've been procrastinating on.

Projects are often really important to me and projects do often go out-of-shape or I will often be uncertain about whether I will be competent enough to cope with a difficult project. So the anxiety and frustration levels can be quite intense, and it all adds up to job stress. A lot of the time I just live the emotions, they are just there, but at times it's a bit much and I've got to back off, to actually deal with the stress.

Much of the time I just get in and try and do the best job I can, put in the hours to make sure that the project will work. But if I put in too many hours I get tired so it doesn't really work in the long run. So I try to ensure I get the chance to chill out. I try not to take work home, like when I get home I take off my work clothes, and everyone knows (kids might talk to me, the dog may come and say hello) I'm no longer the engineer, I'm a parent and spouse. So I tend to use that shrugging off transition. Actually having a spouse is a great stress relief, helps enormously with coping. Sometimes I do go home at the end of the day and rail about things that have

gone wrong. My spouse can also be someone to act as a sounding board if I want an opinion on how to tackle something at work. And work-mates can be really good to talk to as a stress release. So when I come back from a bad encounter where I have been abused, through no part of my own, I can come back and I can talk about that story, and someone else can say, 'that's nothing, I had this!'.

Sometimes I can get really stressed, like if my achievement levels aren't that great, and it's really a matter of just coming back to the fact that I am human. I do what I can, do better than most, probably not as well as some, and just, God, deal with it basically, live with the fact that I'm human.

So being involved in a difficult project can be really exciting and satisfying, but can also be highly frustrating and a time of considerable anxiety. The intensity of these emotions results from my thoughts on how the project is going and whether that implicates my competence, and the consequences there may be for myself, or others, as a result of that competence or lack of it. The emotions that I feel are important to getting through projects. When I'm excited about a project it can really energise me to strive to be involved in and influence the project. And if a difficult project has been really satisfying it can encourage me to take on other difficult projects. On the other hand anxiety can make me more likely to procrastinate, and the stress and frustration of difficult projects can make it hard to get through them and put me off similar projects. So the processes that influence the emotions I have, and the ways that I deal with those emotions are an integral and important part of getting through difficult projects.

The remainder of this thesis explains the conceptual framework that lies behind this story. It describes the nature of engineers' common concern with difficult projects and their competence frontiers in more detail. It expands upon the processes discussed in the story, including description of techniques engineers use to cope with difficult projects that were not mentioned in the story. In addition, other studies of engineers and theoretical concepts from existing literature are discussed in relation to the present study.

1.3 Significance of the study

The importance of individual projects to engineers is evident in the efforts they put into "preserving" projects, as identified by Fletcher (1999). Similarly, Starling (1991) emphasises the importance of involvement in a project to the building up of one's character and reputation. The present study, however, is the first qualitative study to focus on the experiences of, and relationships between, engineers and their projects. In contrast, significant explorative qualitative studies of practicing engineers have focused on the experience of women engineers (Ambrose, Lazarus,

and Nair, 1998; Carter and Kirkup, 1990; Fletcher, 1999; Miller, 1998), crises in construction management (Loosemore, 1997), how technical managers sustain commitment (Starling, 1991), the stressful incidents of graduate engineers (Keenan and Newton, 1985), and the management of project teams (Thamhain and Wilemon, 1988).

There are a number of researchers who have studied stress in professional engineers (see for example Keenan and Newton, 1985; Saleh and Desai, 1990; Sales, Lavanoni, and Saleh, 1984; Sharma and Acharya, 1991), however, these studies have focused on stable coping styles and personality traits rather than the processes that engineers use to cope with stressful situations. The present study contributes to this existing literature because it provides a conceptual framework of coping processes, which will help engineers to learn how to better cope with difficult projects. For example, the present study emphasises the importance of engineers developing realistic conceptual models of the factors that influence project performance and their own performance, which may involve recognising their lack of control over these factors.

The focus of the present study on why engineers find specific projects difficult, contributes to the literature on sources of stress for engineers, in particular the study by Keenan and Newton (1985) of stressful incidents experienced by graduate engineers.

The large number of studies of stress in professional engineers suggests that the extent of emotional involvement experienced by engineers with their work is well recognised. Existing qualitative studies have not, however, focused on this emotional involvement. By focusing on difficult projects the present study has helped to reveal this emotional intensity and to account for its formation.

Many existing studies of engineers emphasise the importance of engineers' relationships with the other people who are involved in their work. Engineers in the present study similarly emphasised the importance of good relationships. The present

study also identifies conditions that influence when engineers do, and do not, put effort into enhancing relationships.

The present study emphasises the importance of engineers having projects of appropriate difficulty, access to social support and experts, developing realistic conceptual models of the causes of performance, and developing appropriate levels of ownership of their projects. These can be significantly influenced by engineers' supervisors, and by engineers themselves, through greater awareness of the processes that occur, as they are involved in difficult projects. Such awareness could be developed through engineers reading qualitative research about engineers, such as the present study. This greater awareness has the potential to help engineers to get through difficult projects and to reduce the extent of stress experienced by engineers during project involvement.

1.4 Overview of the thesis

This thesis contains nine chapters. The current chapter has introduced the main concern of engineers, regarding difficult projects, as a concern for their competence frontiers. The processes that engineers engage in as they go about resolving this concern have been introduced descriptively through a story. In addition, the theoretical and practical importance of the study has been summarised.

Chapter Two describes the grounded theory method, and discusses several proponents' views of it. The chapter then describes the process of using grounded theory in the present study.

Chapter Three describes engineers' perspectives on the features of project involvement that contribute to project difficulty. It identifies their common underlying concern about the interrelationships between involvement in difficult projects and their competence frontiers. Chapter Four describes the nature of engineers' competence frontiers in further detail.

In Chapters Five to Seven the ways that engineers cope with difficult projects are conceptualised as three concurrent processes ("*getting through the project*", "*have I done a good job?*" and "*taking ownership*") that involve engineers managing their competence frontiers. Chapter Eight summarises and links these three concurrent processes, and describes the formation and nature of emotions that result from these processes. These emotions can then, in turn, influence the processes. A complex model of the interrelationships between emotions and the three processes is presented. This emphasises the importance of all three processes to the ability to get through difficult projects.

Chapter Nine concludes the thesis with a conceptual summary of the theory, discussion of the contributions of the thesis to literature and engineering practice, and an outline of potential topics for future research.

Chapter 2
Methodology, Data Collection and Analysis

2.1 Introduction

This study used the Grounded Theory method to investigate how civil engineers cope with difficult projects. This chapter begins with a description of the grounded theory method, and then discusses various grounded theory proponents views of grounded theory and their associated approaches. The chapter then describes the processes of collecting and analysing data used in this study.

2.2 Grounded theory methodology

A grounded theory focuses on how the participants in a substantive area[3] resolve a common underlying concern. This means that the research focuses on the concerns of the participants rather than the concerns of the researcher. Use of the method results in a grounded theory, which is an integrated set of conceptual hypotheses that are systematically generated from the data (Glaser, 1992). The central theme of the grounded theory method is generating theory that emerges from research data rather than preconceived hypotheses. Consequently a grounded theory is relevant to people in the substantive area. The theory fits their situation, and provides them with some prediction and control in that situation.

The grounded theory method arose from research into dying by Barney Glaser and Anselm Strauss in the 1960's. They wrote a monograph, *Awareness of dying,* published in 1967 as a result of this research. Many queries about their research methods followed, motivating them to write *The Discovery of Grounded Theory* in 1967 (Glaser, 1998, p.21). In writing this book Glaser and Strauss were attempting to strengthen the mandate for generating theory as opposed to verifying existing theories (Glaser and Strauss, 1967b, p.10).

[3] A substantive area is a social setting or social group. In this thesis the substantive area is civil engineers in New Zealand.

Glaser and Strauss (1967b) turned method around from using data to test theory to using data to generate theory, so grounded theory is therefore validational rather than verificational in nature (Rennie, 1998, p.113). Consistent with this validation stance, grounded theory researchers do not seek to prove their theories but merely to demonstrate plausible support for their theories (Taylor and Bogdan, 1998, p.137).

Using the grounded theory method should result in a theory with the characteristics of relevance, fit, workability, and modifiability (Glaser, 1992, p.15). Relevance refers to the research being applicable to the concerns of the people in the substantive area, rather than just a pet interest of the researcher. Often what the researcher thinks will be the central concern of the participants is not their main concern. For this reason the focus of grounded theories often shift during the research (Glaser, 1998). Fit refers to the theory fitting the reality in the eyes of the people in the social setting that has been researched, that is, the concepts of the theory express the patterns in the data. Workability refers to the theory's ability to explain, interpret and predict what occurs in the social setting. The modifiability of grounded theories reflects the view that grounded theories are not verified truths, but propositions that may be modified by comparison to new data. The development of a grounded theory is considered part of an ongoing research process, not just an end point. Parsimony and scope are additional characteristics of grounded theories that are occasionally referred to by Glaser (Glaser 1992, p.116; Glaser and Strauss, 1967b, p.111). Parsimony and scope taken together refer to the ability of the theory to have considerable explanatory power over a wide range of situations, with few concepts.

Strategies of grounded theory include simultaneous collection and analysis of data, comparative analysis that includes writing memos of the emerging conceptual theory, sampling to refine the emerging theoretical ideas and the integration of the theoretical framework (Charmaz, 2000, p510-511).

2.2.1 Symbolic interactionism

The general perspective of human behaviour assumed by grounded theorists is that of symbolic interactionism, arising from Strauss' background in this perspective. Central to symbolic interactionism is the focus on the symbolic nature of activity that

is constructed and interpreted both within the self and between the self and others (Woods, 1996). Blumer (1969, p.2, cited in Crotty (1998, p.72)) describes the basic assumptions of symbolic interactionism as follows:

> 'that human beings act towards things on the basis of the meanings that these things have for them'; 'that the meaning of such things is derived from, and arises out of, the social interaction that one has with one's fellows'; 'that these meanings are handled in, and modified through, an interpretive process used by the person in dealing with the things he encounters'.

Symbolic interactionism traces back to George Herbert Mead's (1863-1931) work, much of which "should be seen as a *reaction* to those who believed that measuring overt behavior alone was enough to understand humans" (Charon, 1979, p.31). Mead argued for the importance of humans' ability to reason and the importance of symbolic and social action of human beings, rather than just seeing humans as physical organisms. The philosophy of pragmatism is important to Mead's approach to truth, with truth existing for humans only by our defining it (Charon, 1979, p.29). To understand human behaviour then, it is necessary to understand the meanings that people ascribe to things. For example, perceptions of feedback about project performance can be interpreted by engineers as symbolic of other peoples' thoughts on the engineers' competence frontiers. Grounded theorists study the meanings and perspectives that people have, and how these influence their actions.

Mead's work was influenced by Darwin's emphasis on process (Charon, 1979). Symbolic interactionism focuses on the process of interaction both with the self and between the self and others, rather than features such as personality or social structure. Similarly, grounded theorists study the processes involved in people's ongoing resolution of their main concern and do not include the traits of people or social/contextural variables in the theory, unless they emerge as important. With the emphasis on process, symbolic interactionism sees meanings and actions as constantly undergoing change, through interaction. For example, though self-reflection and/or discussion with peers many engineers interviewed in the present study became more cautious about associating negative feedback on the performance of their projects with their competence frontiers.

In order to understand human behaviour the symbolic interactionist perspective requires the researcher to focus on understanding human experience.

2.2.2 Focus on human experience

Grounded theory is normally used as a method for developing theory that focuses on human experience. The philosophical basis of this focus is eidetic phenomenology, which is based on Edmund Husserl's interest in the epistemological question: "what do we know as persons?" (Cohen, 1994, p.142). The goal of eidetic phenomenology is the description of the meaning of an experience from the perspective of those who have had that experience. The incorporation of eidetic phenomenology into grounded theory arose from Glaser's experience with the method of *explication de text* at Sorbonne, "reading closely line by line to ascertain what exactly the author is saying without imputing what was said, interpreting it or reifying its meaning" Glaser (1998, p.24). That is, Glaser saw that "...there was, it seemed to me, no need to force meaning on a participant, but rather a need to listen to his genuine meanings, to grasp his perspectives..." (Glaser, 1998, p.32).

Eidetic phenomenology is incorporated into grounded theory research most typically by the use of in-depth interviews that are open-ended. In-depth interviews are focused on understanding the informants' perspectives on their lives, experiences or situations (Taylor and Bogdan, 1998). In my study, for example, my early interviews with engineers focused on their experiences of being involved in ill-defined and difficult projects, rather than testing any existing hypotheses. This meant that I did not have any pre-set questions for these early interviews, rather, I asked questions relevant to gaining a better understanding of the engineer's perspective and experiences.

A grounded theory study begins with the researcher setting aside their preconceptions and entering a field of study with a mind that enquires "what have we here?" (Brooks, 1998, p.19). This means that the researcher does not begin the study with a pre-conceptualised problem, but rather an area of interest that they wish to explore. In

addition, the researcher initially avoids reading the substantive literature[4], instead reading literature on formal theory[5] or in fields outside their study. This means that that researcher does not come to the study with a specific theoretical framework with which to interpret the data, instead using theory that is relevant to the data. The literature in the substantive area is incorporated as data into the research process after the researcher has made significant progress in developing his or her own theory of the area (Glaser, 1992, p.32).

While the grounded theory researcher continues to attempt to understand the experiences of people from those peoples' perspectives the researcher also attempts to conceptualise those experiences in order to develop the theory. Interpretation can be considered to occur not only as the researcher analyses data, but also during interviews. For example, by asking questions and probing for meanings the interviewer encourages people to articulate things that they have not previously articulated, thus knowledge and social meaning are constructed during interviews (Taylor and Bogdan, 1998, p.98). By focusing on peoples' perspectives of their experiences researchers develop conceptual theory that fits the experiences of their research participants. As the theory develops a researcher explores many of the emerging concepts in subsequent interviews. For example, in the present study the content of interviews shifted from exploring engineers' experiences with projects at the start of data gathering, to only asking questions that explored the emerging theory in the final interviews.

By setting aside their existing theoretical perspectives researchers may discover that areas of formal theory with which they are unfamiliar, give the most conceptual insight to their data. The preparedness of researchers to seek out and become aware of a range of formal theory is therefore important to using the grounded theory method. This preparedness is important to "Theoretical Sensitivity", a term used by Glaser (1992) to describe the ability to give conceptual insight, understanding and meaning to substantive data (p.27). Theoretical sensitivity is a personal attribute of

[4] Substantive literature refers to the literature pertaining to the type of social group that is under study.
[5] Formal theory refers to a "theory developed or discovered for a conceptual area of inquiry – such as status passage, social stratification,..." (Glaser, 1992, p.99).

the researcher that is enhanced through practice, and study of conceptual work and theoretical literature (Glaser, 1992, p.27-28).

Grounded theory develops conceptualisations of peoples' perspectives of their experiences with comparative analysis.

2.2.3 Comparative analysis

Glaser's background included study of quantitative methodology and qualitative mathematics with Paul Lazarsfeld at Colombia University (Glaser, 1998, p.21-22). This involved comparing different variables to each other, in order to identify a core variable that is related to the other variables and accounts for the greatest variation in action in the field under study. Strauss' background involved the comparison of social units as a means of gathering and analysing data (Brooks, 1998). Comparative analysis uses both of these approaches.

Comparative analysis requires the development of labels that conceptualise data. This is an interpretative process known as "coding", and the labels are described as "codes". Codes may consist of words or phrases used by participants, which are referred to as "in vivo" codes, or labels that the researcher develops. An example of an in vivo code used in this study is the phrase "taking ownership" (of a project), which was used by several participants. A grounded theory 'fits' the data through the development of codes that reflect the data. Often researchers alter or refine the words that are used for a code name as their understanding of the concept develops, or more appropriate words or phrases come to mind.

A grounded theory is not a lengthy conceptual description of all the data, but an integrated theory (a theory of interrelated concepts) that has the characteristics of parsimony and scope. Grounded theory is constructed at a number of conceptual levels, and terminology has been developed to describe the relationships between these different levels. The "core category" is the highest level concept that accounts for most of the ongoing behaviour in the area being researched (Glaser, 1998, p.135). The core category will relate to most of the other concepts that are developed in the research. These concepts are called categories or properties. A category is a higher

level concept than a property: a property is a concept about a category (Glaser, 1998, p.135).

Coding data generates a very large number of concepts. In order to produce a parsimonious theory it is important that the grounded theory researcher reduces the number of codes. One way to do this is to raise the level of conceptualisation to abstract concepts that are applicable to a range of situations. This is achieved by conceptualising commonalities between different incidents in the data and comparing new incidents to existing codes. In addition, by comparing different categories (high level codes) to each other, the researcher attempts to discover underlying uniformities that can be reformulated with a smaller set of (even) higher level concepts (Glaser and Strauss, 1967b, p.110). Focusing on one common concern of the participants and the associated development of a core category that accounts for the resolving of that concern is another way that the grounded theory researcher limits the generation of concepts.

Initially the researcher does not know what the common concern is, and so he or she uses the "open coding" approach. Open coding involves coding all the data. Through the process of open coding researchers develop an understanding of the common concern and the core category of their studies. As this understanding develops they begin to use the "selective coding" approach, which involves limiting coding to those variables that relate to the core variable in sufficiently significant ways to develop a parsimonious theory (Glaser, 1978, p.61). Not only do researchers selectively code data, they are purposefully selective in their approach to obtaining new data. This process is known as "theoretical sampling", and involves them selecting data sources and asking participants questions that yield data that is relevant to their emerging theories. This means that their questions constantly change as their emerging theories develop. Theoretical sampling enables researchers to gain data that is pertinent to the saturation of categories and properties.

Saturation refers to the theory having categories and properties that account for all the data that pertain to the core category. Saturation therefore, refers both to theoretical

completeness (Glaser, 1998, p.157) of the theory as a whole, and to the saturation of individual properties of the theory. Indeed I think a significant challenge of grounded theory research is to be able to simultaneously think at the level of the core category, and the detail of properties. On the one hand, researchers do not want to expend all their effort collecting the same data over and over again based on the same questions, for then they would not achieve theoretical completeness of the theory as a whole. On the other hand, they want to be fairly confident that they are saturating the individual properties of the theory. Glaser (1998) refers to saturation in terms of being "within the researcher's sources of time, money and energy" (p.158). In other words a researcher cannot collect limitless quantities of data, so although the theory should account for all the data that pertains to the core category and its properties, each property may not have data from a large number of interviews. I found that questioning engineers about processes that I had conceptualised from existing data contributed significantly to my sense of saturation.

Researchers write up descriptions of their codes and how those codes relate to other codes and existing theory, in written memos. Memos may vary from a few words to several pages long (Glaser, 1998, p.178). The researcher steadily builds up a bank of memos, which can be used in the constant comparison process. The comparison of categories or properties and their relationships is undertaken by sorting through the existing memos. Sorting is important to the development of higher level concepts, to integrating the theory and to identifying parts of the theory that require further investigation.

The development of the characteristic of workability arises from the theory fitting the experiences of the participants, and having parsimony and scope. Workability requires the theory to be applicable to a wide range of situations and this is why it is important for the researcher to raise the conceptual level of many of the concepts in the theory through memoing and sorting.

The purpose of memoing is to record ideas, and it is important that researchers write memos with freedom from the things that usually constrain writing, such as concern

about structure and punctuation (Glaser, 1978; Glaser, 1998). The emphasis needs to be on getting ideas recorded, with sorting and editing being undertaken later on.

Writing up the grounded theory involves writing from the basis of sorted memos. I found that the process I developed in writing the grounded theory influenced my approach to writing the introduction chapter, the present chapter and the conclusions chapter of my thesis, in addition to the chapters that describe the theory. Rather than starting with a predetermined structure for each chapter I would focus on getting on with writing the ideas that I wanted to incorporate in that chapter. I would then code this writing looking for the central idea in each paragraph or sentence, and then sort these coded pieces of my writing. After using this approach I found out that it is a recognised style of writing called "free-writing" (Taylor and Bogdan, 1998, p.172). I found the free-writing style useful to writing about complex interrelated topics. Using this style reflects an emergent rather than a forcing approach to structuring ideas, which is the central theme of grounded theory research.

In summary, grounded theory is a research method that focuses on the generation of theory, through the concurrent acquisition and analysis of data, instead of focusing on the verification of existing theory. Grounded theory researchers enter the field without preconceived hypotheses, and seek to understand a common underlying concern of the people and the way they go about resolving that concern. The researchers develop an integrated conceptual theory of the process of resolving that common concern by conceptualising and comparing the data.

2.3 Discussion of grounded theory

Glaser wrote *Theoretical sensitivity* in 1978 to explain how to do grounded theory giving more detail than that provided in *The discovery of grounded theory.* In 1990 Corbin and Strauss wrote *Basics of qualitative research: grounded theory procedures and techniques*, which modified the original, orthodox grounded theory method. Glaser explicitly attacked this book in *Basics of grounded theory analysis: emergence vs forcing* (1992), arguing that the techniques advocated by Corbin and Strauss would force the development of theory rather than allowing it to emerge from the data. It

became considered that there were two variants of grounded theory (Stern, 1994; Wilson and Hutchinson, 1996; Locke, 1996; Rennie, 1998). More recently Charmaz (2000) describes an approach to grounded theory that is different again, and most closely fits with my experience of doing grounded theory.

The differences between the variant views of grounded theory held by the respective researchers are based on different assumptions about the nature of reality (ontology) and researchers' relationships to the world they study and therefore what can be known (epistemology).

Different views of ontology and epistemology are commonly described as positivism, post-positivism and constructivism. Description of the assumptions associated with each of these views is necessary background to further discussion of the variant views of grounded theory.

2.3.1 Positivism

The traditional view of science, still dominant in many fields, is termed positivism. The ontology of positivism is realism: an apprehendable reality is assumed to exist, driven by immutable natural laws and mechanisms (Guba and Lincoln, 1994, p.109). That is, an objective reality is assumed to exist independent of human understanding (Crotty, 1998). The epistemology of positivism is described as objectivism: meanings are assumed to exist in objects independently of any consciousness (Crotty, 1998, p.10). The investigator and the object are assumed to be independent entities and the researcher can study the object without either influencing or being influenced by it (Guba and Lincoln, 1994, p.110). It is believed that scientists passively note down the laws of nature rather than actively construct scientific knowledge. According to Peirce (1965) there are three modes of inference: abduction, which is hypothesising; induction, the testing of abductions; and deduction, the demonstration of truth by deriving a conclusion that follows from its premises (Rennie, 1998, p.111). The traditional portrayal of positivistic research involves abduction, induction and deduction in turn (Rennie, 1998). In effect positivism results in claims to verified truths.

2.3.2 Post-positivism

Challenges to positivism began when physicists in the early 20th century became concerned with the inability of science to determine the dynamics of sub-atomic particles (Crotty, 1998, p.29). This was followed by Sir Karl Popper developing the view that scientists are involved in a process of conjecture and falsification (Crotty, 1998, p.31). That is, science develops not by scientists making a discovery and then proving it right, but by making a guess and being unable to prove it wrong. For this reason scientific statements must always remain tentative.

Thomas Kuhn, a student of theoretical physics, undertook a study of the history of science (Kuhn, 1970). As a result of this work he emphasised that scientists work in, and out of, a background of theory. This theory, which comprises beliefs about science and scientific knowledge, is called a paradigm. Most science takes place within the existing paradigm, but a crisis occurs when the paradigm proves inadequate; this initiates a scientific revolution and the development of a new paradigm. Significant advances in science occur when there are radical shifts in the way that scientists view reality. Kuhn's view of scientific work is not of detached scientists producing objective, valid and un-challengeable findings: instead science is a very human affair, influenced by human values and interests (Crotty, 1998 , p.36).

The ontology of post-positivism is critical realism: a "real" reality is assumed to exist, but it is only imperfectly and probabilistically apprehendable due to flawed human investigation and the intractability of nature (Guba and Lincoln, 1994, p.110; Lincoln and Guba, 2000, p.168). Epistemologically, objectivism remains an ideal, but findings are at best probably true (Guba and Lincoln, 1994, p.110). Claims about reality must be subjected to the widest critical examination to help to apprehend reality as closely as possible. The aims of post-positivism are accuracy, prediction and control.

2.3.3 Constructivism

The aims of constructivism are understanding and reconstruction. Constructivism is usually considered to have a relativist ontology: realities are apprehendable as mental constructs that are socially and experientially based. This means that there are

multiple realities, although there can be patterns to reality, as elements are often shared among many individuals and even across cultures (Guba and Lincoln, 1994, p.110).

Epistemologically, constructivism recognises the mutual creation of knowledge by the researcher and the researched. That is, it is through the interaction between the investigator and the object that knowledge is constructed (Guba and Lincoln, 1994, p.116).

I have described the assumptions of positivism, post-positivism and constructivism. Where then do the variant views of grounded theory fit? These variant views are described as the "orthodox" view" (that described by Glaser), the "Strauss/Corbin" view, and the "constructivist" view described by Charmaz.

2.3.4 Orthodox grounded theory

Orthodox grounded theory holds the ontological view of symbolic interactionism: that people are active, interpreting beings and their perspectives influence their actions. It assumes however, that there is a common concern and resolving of that concern in the area of study, that is, there are patterns to people's behaviour. Orthodox grounded theory acknowledges that situations change and hence theory that applies at one time will require modification at future times or in different settings. Thus it is assumed that there is a real but changing world.

Orthodox grounded theory aims for conceptualisation that is grounded in data, rather than accuracy or conjectured conceptualisation (Glaser, 2001). "Grounded theory is not findings, but rather is an integrated set of conceptual hypotheses. It is just probability statements about the relationship between concepts. Again it is not findings!" (Glaser, 1998, p.3). Glaser's 2001 publication advocates use of grounded theory method to develop very conceptually dense theories, rather than description of the field of study.

Charmaz (2000) and Locke (1996) both place Glaser's view of grounded theory with postitivism. Neither of these authors had read Glaser's latest publications (1998,

2001) which provide further clarity of orthodox grounded theory, and Glaser's perspectives of it.

Locke places orthodox grounded theory within positivism because Glaser sees agency residing with the neutrality of the grounded theory procedures. Glaser (1998) does recognise that researchers can and do influence their research in a myriad of ways, however he says that the process is neutral to bias (Glaser, 2001, p.153). In saying this he may not mean that grounded theory methods remove all bias, but that bias does not matter to grounded theory, because the purpose of grounded theory is conceptualisation rather than accuracy. It appears from Glaser's writing as if he assumes that sufficient accuracy will be attained through use of the method, and so the researcher can cease to focus on accuracy and can instead get on with conceptualising. Perhaps a small level of inaccuracy does not matter to grounded theory research, because grounded theory can always be modified.

Charmaz places Glaser's position on the basis of his 1978 and 1992 publications as close to traditional positivism. This is because of the "assumptions of an objective, external reality, a neutral observer who discovers data, reductionist inquiry of manageable research problems, and objectivist rendering of data" (Charmaz, 2000, p.510). One of Glaser's concepts regarding doing grounded theory is that "all is data", "whether private or public, revealed or concealed, words or behaviour" (Glaser, 2001, p.154). This use of tacit data, in addition to overt data, is an important issue that I discuss further later on. For the purposes of this discussion, Glasers' treatment of "all is data" is for the grounded theory quest to conceptualise "what is really going on" (Glaser, 2001, p.155), suggesting that he still assumes an objective, external (although changing) reality.

As discussed above, Glaser does recognise that researchers can influence their research. He also recognises that concepts are constitutive of humans (Glaser, 2001 p.154). These expressions of his perspective suggest that he does not see grounded theory researchers as completely neutral observers who discover data.

Glaser's latest publication (2001) emphasises the development of conceptual theory. If anything this places greater emphasis on reductionist inquiry of manageable research problems. He also advocates a very conceptual writing style, which encourages elevation of concepts above data and involves the presentation of few quotes from the data: an objectivist way of treating data. Note, however that Glaser does consider that it is very important that concepts "fit" the experience of the people in the field.

Glaser (2001) sees many aspects of qualitative research that focuses on description to be holding onto positivist proclivities, such as the emphasis on accurate rather than distorted presentation of participants' voices.

I think that because Glaser recognises that researchers can force their data, that concepts are constitutive of humans (Glaser, 2001 p.154), and the grounded theories are conceptual hypotheses rather than findings, orthodox grounded theory fits more closely with post-positivism than positivism. The very conceptually dense style of writing that he uses and advocates is, however, consistent with his objectivist background. The focus of orthodox grounded theory is on conceptualisation rather than accuracy. It makes use of tacit as well as overt data.

2.3.5 Strauss/Corbin grounded theory

Strauss and Corbin (1990) presented guidelines for doing grounded theory that were very prescriptive, effectively advocating one framework for grounded theories to fit. Glaser (1992) describes the focus of their approach as "full conceptual description". Strauss and Corbin stick close to overt data and espouse verification (Charmaz, 2000, p.525, 510). The critical realism ontology of the Strauss/Corbin approach is consistent with orthodox grounded theory. Epistemologically they are very aware of, and focus on, minimising the influence of the researcher, rather than side stepping the issue as Glaser does. This suggests that their perspective fits with post-positivism as considered by Charmaz (2000, p.510).

2.3.6 Constructivist grounded theory

Charmaz (2000) advocates a constructivist approach to grounded theory with particular emphasis on meaning, and feeling. She argues that objectivist grounded theory approaches may create complex theories, but remain outside of the experience (of the participants), and risks cloaking analytic power in jargon (Charmaz, 2000, p.525). To overcome these problems she listens to peoples' stories with "openness to feeling and experience" (p.525). She studies tacit meanings, and she sees if explicit concepts that emerge from certain interviews are implicit in other interviews (p.526). She uses labels for her concepts that attempt to preserve images of experience, and attempts to evoke experiential feeling through the style of her writing (p.526-527).

Like the other approaches to grounded theory Charmaz's (2000) constructivist approach makes the assumptions of symbolic interactionism, that "people create and maintain meaningful worlds through dialectic processes of conferring meaning on their realities and acting within them" (p.521). The constructivist approach recognises that the development of a grounded theory emerges from the researcher's interaction with the field. It claims to present "*a* reality, as we understood both our own experience and our subjects' portrayals of theirs", rather than objective, true, external reality (Charmaz, 2000, p.523).

2.3.7 Discussion

Since its initial description in Glaser and Strauss (1967b), with its emphasis on using data to generate theory, rather than test theory, the grounded theory method has been used in many different academic fields. Different styles of doing grounded theory have developed, perhaps in part because one can only learn the subtleties of the method by using it, and because of the differing purposes for which the method is used. For example, Glaser's purpose of using grounded theory is for the development of dense, integrated conceptual theory, the Strauss/Corbin approach is for full conceptual description of the field and Charmaz's purpose is to study meaning and experience. Although these are the primary focuses of each proponent there is considerable overlap. For example, Glaser and Strauss/Corbin do make use of peoples' meanings and experiences, and Charmaz also develops conceptual theory. The same overall procedures are used with all approaches, but there are considerably

different nuances between the approaches that reflect their purposes and ontological and epistemological assumptions.

I believe my research for the present study has been influenced by all three approaches. I began the study with a fairly post-positivist approach. Strauss and Corbin's (1990) description of coding influenced my initial work. This combined with my (incorrect) understanding that I had to account for all data contributed to quite descriptive sections in my theory. Initially I focused on overt data, however it was only when I accepted the need to focus on the emotional expressions of engineers (often behavioural rather than verbal) that I was able to develop an integrated conceptual theory. Frequent reading of Glaser's 1978, 1992, and 1998 descriptions of grounded theory helped to support me through the process of undertaking grounded theory research. Meanwhile reading about qualitative research contributed to my comfort with constructivist understandings of ontology and epistemology. I read Charmaz's description of constructivist grounded theory after I finished the present study, and I found it to be fairly similar to my own approach. In particular, I found that there was considerable art in the writing of grounded theory that captures the heart of experience. The very conceptually dense style of writing advocated by Glaser can, I think, make the theory remote to readers. Writing the narrative in the introduction of this thesis was my attempt to evoke the experience of being involved with difficult projects. This narrative was structured around the conceptual theory developed in this study.

If researchers take a post-positivist view of grounded theory, and assume that to mean that only very explicit data can be used, then some of the great strength of grounded theory could be lost. That is, the ability to identify important social-psychological processes. In Charmaz's (2000) terms, unless you focus on the meaning of people's experiences then you risk remaining outside that experience. Data for grounded theory is not fully explicit in that 'this main concern and its resolving is in the voice and behaviour of the participants but they do not know it as a conscious awareness conceptually" (Glaser, 2001, p.51). In the present study the description of factors that influence the difficulty of projects (presented in Chapter Three) is based on explicit,

overt data. While interesting and useful it remains outside the heart of the experience of being involved in difficult projects. Development of the theory of the competence frontier (based on implicit and explicit data) was necessary to capture what it feels like to be involved in difficult projects.

In undertaking my research I have used a combination of techniques in learning to use the grounded theory method. I had the advantage of having valuable guidance from a supervisor trained with Barney Glaser, and another supervisor with experience in qualitative research. I have read most of the literature written on grounded theory methodology, and some texts describing the development and products of grounded theory research. Perhaps most important, however, has been learning to use the grounded theory method by doing it: "It is only by applying the methods in research that one gains the sufficient, delayed understandings of how they work and what they produce, and the openness and flexibility to apply them to diverse fields of substantive study" (Glaser 1992, p.17-18). Description of the research process that has formed my experience of using the grounded theory method, and the subject of this thesis, follows.

2.4 Description of this study's research process

In describing this study's research process I have attempted to provide a truthful account that reveals the research process. It is an account of a researcher who was new to the methodology and much of the formal literature, when beginning the study. It reveals a process of learning, where mistakes were made that temporarily forced or slowed down the research process. However, the process eventually developed an integrated theory that accounts for how civil engineers cope with difficult projects.

I begin the description of the research process by briefly outlining my background that led to this study and in doing so I describe some of the biases I brought to the study. The types of data and the processes used for gathering the data are then described in Section 2.4.2. Finally, the process of developing the theory is described in Section 2.4.3. Description of the research process has required occasional references to concepts that have been developed during the research. Therefore this

section will be more understandable if read in conjunction with the following chapters that describe the grounded theory developed by this research.

2.4.1 Background that led to the study

My interest in difficult projects arose from my experience of being involved in a difficult project when working as a graduate engineer, as described in Chapter One. I felt that the people involved in the project, including myself, could have done a much better job. I attributed the reasons why we did not do a better job to a combination of a lack of cognitive engineering techniques and to management problems, although I also recognised that the nature of the project was, in itself, very challenging. I returned to university to begin a Ph.D. with a strong motivation to help civil engineers to develop better quality solutions. During my early thesis work I alternated between prescriptive approaches (establishing what engineers should do) and descriptive approaches (finding out the perspectives of engineers) before eventually deciding to use the grounded theory method.

The descriptive approach in my earlier work included qualitative interviews with mainly non-structural civil engineers, which explored factors that influenced the quality of solutions. These engineers emphasised that projects for which prescriptive codes were not applicable were both challenging and enjoyable, with increased potential for better or worse quality solutions. I termed such projects "ill-defined". The dominant theme of my prescriptive approach was the proposition that there are parallels between the inductive approaches of qualitative researchers and practicing civil engineers. In Walls (1998), for example, I argued that information gained from inductive approaches could be systematically used to imagine the potential effects of different design options.

Following this report I gained the opportunity to be mentored by grounded theory researcher, Dr. Ian Brooks, and qualitative researcher and engineering academic, Dr. Anne Ditcher, so I decided to do a grounded theory study focusing on how civil engineers deal with ill-defined projects.

At this stage I still had a strong engineering orientation: I was focused on the pragmatic problem-solving strategies of engineers, rather than a social-psychological orientation. The influence of my engineering orientation on the process of the research is discussed further in section 2.4.3. My initial lack of knowledge of social-psychology is likely to be fairly typical of grounded theory researchers, as Glaser found that many people doing grounded theory research are new to social research (Glaser, 1998, p.7).

My early research experience was very useful in developing personal characteristics that enhanced my ability to do grounded theory research. It is Glaser's view that not every researcher has the personal characteristics suited to grounded theory research (Glaser, 1992, p.12). In the following extract he describes necessary personal characteristics.

> The grounded theory researcher must feel comfortable with uncertainty, ambiguity and confusion that comes initially and during various stages of grounded theory for brief periods. He (sic) must trust that uncertainty, ambiguity and confusion are a useful path to being open to emergence. He must trust to emergence and trust that the social organisation of social life exists to be discovered. (Glaser, 1998, p.44).

Characteristics enhanced in my early research experience were the ability to be comfortable with uncertainty, ambiguity, confusion, and to cope with the sense of making slow progress. In fact, when undertaking the grounded theory study I felt far more in control of my thesis than I had earlier. For the first time I actually had a research method to use, and further, I had mentors experienced in grounded theory and qualitative inquiry.

2.4.2 Data collection

This study was based mainly on interviews with some use of three sources of documentation. Interviews were used as the main source of data because they are highly productive in terms of the relevance and quantity of data. Data from interviews are highly appropriate for grounded theory studies as they allow researchers to understand the perspectives of the interviewees. This is important to understanding the main concern of participants and how they go about resolving that main concern. I will now discuss the interviewing process before going on to discuss the documentation that I used.

2.4.2.1 Interviews

In traditional research, focused on the verification of theory, researchers are concerned with the representativeness of the data samples, and samples are typically selected randomly. In qualitative research, such as grounded theory, the emphasis on developing theory means that the researcher samples purposefully for information richness (Kuzel, 1992). For example, Glaser (1998) describes the grounded theory approach to sampling as resulting in an ideational sample (a sample used to study an emergent concept) not a representative sample (p.159). Glaser (1992) emphasises, however, that researchers should begin their studies by moving into a substantive area of interest with no problem or concept in mind (p.22). Once the core concept has emerged Glaser (1992) then advocates studying other social units (substantive areas): "remember that grounded theory research is the study of abstract problems and their processes, not units" (p.24). Glaser's emphasis on an ideational sample reflects his interest in shifting grounded theories of substantive areas towards more formal theory.

The concept of ideational sampling can apply to a study that investigates just one substantive area (such as the present study) as the selection of participants and the questions can still be focused on the emerging conceptual theory. The strategies of theoretical sampling and purposive sampling were used in this study to gain a good ideational sample that also provided a wide range of perspectives from the substantive area. Theoretical sampling was described in section 2.2.3, and examples of theoretical sampling in my study occur later on in the current section and the following section.

"Purposive sampling", by aiming for maximal variation, involves using cases that are as different as possible to disclose the range of variation in the field (Flick, 1998, p.70). Glaser and Strauss (1967b) argue that data from many diverse situations facilitates the development of general concepts that are relevant to most situations (p.243). In the present study I undertook forty interviews with thirty-nine people. In one case I interviewed two people at once. I also interviewed two people twice. Selection of interviewees in my study involved a combination of opportunism and

purposive sampling. I took advantage of opportunities that arose to interview any person who was or had undertaken civil engineering type work. This was set, however, in a framework of purposive sampling where I ensured that I had maximal variation in the sample.

Variation between the interviewees occurred in a number of dimensions. A wide range of ages, level of responsibilities and experience were included, ranging from an interviewee with just nine months experience to a retired engineer. The range of civil engineering fields included environmental, hydraulic, structural, marine, resource consent assessment, geotechnical, project management, roading, and hazard and asset management. People worked for contractors, councils or consultancies. The consultancies ranged in size from one person to the largest in New Zealand. Interviewees came from five cities in New Zealand: Auckland, Wellington, Nelson, Christchurch and Dunedin. While the majority of interviewees had a civil engineering degree, others had science, mechanical engineering or resource management degrees.

Women are a very small minority of practicing civil engineers. In this study nine of the thirty-nine participants were women. Women were thus over-represented in comparison to their proportions in civil engineering practice. This level of representation of women was necessary to clarify whether there were substantial differences in the experiences of women in comparison to men, which was indicated could be the case during the early stages of the research process.

Four different strategies were used to gain contact with potential interviewees. One strategy was to ring a company or council and ask to speak to a civil engineer. I sent an email to the Association of Women Engineers (NZ), which resulted in a number of interviews. I contacted some of my existing engineering acquaintances (two of whom I would class as my personal friends), and also obtained contacts who were suggested by other interviewees. I had a very positive response to my requests for participants, with some people being prepared for me to interview them on the same day that I contacted them. There was only one definite refusal to partake in the study, by an

engineer who was not able to fit an interview into his timetable, but was nevertheless interested in the study. The willingness of people to partake in the study may reflect the importance of difficult projects to their lives, although Taylor and Bogdan (1998) note that people are generally willing to talk about themselves and are often honoured by the prospect of being interviewed for a research project (p.95).

Most of the interviews were undertaken in person, in meeting rooms or private offices at the participant's work. A few interviews took place in the participant's home, one at an airport and a couple in my own office at university. In all interviews there was a reasonable level of privacy to ensure that other people were not eavesdropping on the interview, with the exception of the interview at the airport. The interviewee at the airport did not appear to be inhibited by the presence of other people. Seven of the interviews took place via telephone. In all but one case the interviewees were using a telephone at home and it appeared that they could speak freely about their work experiences.

Initially the interviews were based on engineers describing ill-defined[6] projects they had been involved with. Implicit in this topic is the notion that it is the characteristics of projects that are the concern. However, I soon found that engineers were concerned with difficult projects that may or may not be ill-defined. It also became evident in the eighth interview that it was not so much the characteristics of the project that were of concern, but rather engineers' relationships to their projects, for example whether they had relevant experience for their projects. From the tenth interview onwards I began asking for descriptions of engineers' involvement with difficult/challenging projects, and later on I asked them to contrast difficult and easy projects.

The interviews become more structured as the research progressed, that is, I was theoretically sampling. For example, being involved with a project was often quite an intense emotional experience for engineers, so from the fifteenth interview I began to

[6] Ill-defined projects include those projects where this is a poorly understood problem with no one obvious solution, or a lack of applicable prescriptive codes.

ask questions about the emotional aspects of being involved in difficult projects, while continuing to ask about their involvement with particular projects. To aid the investigation of aspects of the emerging theory, I developed and continued to modify an interview guide. An interview guide is a listing of topics that the interviewer should attempt to cover in the interview rather than a formal schedule of questions to be asked in a set order (King 1994, p.19).

Establishing rapport is important to participants sharing their perspectives and feelings with a researcher (Taylor and Bogdan, 1998, p.48). One way to facilitate the development of rapport is to establish what you have in common with the participants (Taylor and Bogdan, 1998, p.49). My background, with an engineering degree and a couple of years of work experience as a graduate engineer, was described in the information sheet given to interviewees, and helped me develop rapport with interviewees. My background meant that I had some experiences in common with the interviewees and that I was familiar with a lot of the engineering terminology, which also enhanced my theoretical sensitivity.

Qualitative interviews are modelled on conversations between equals (Taylor and Bogdan, 1998, p.88). The conversational style of interviews is important to the development of knowledge. Kvale (1996) sees the conversational style of qualitative interviews as constructing knowledge through the interchange of views between the interviewer and the interviewee when conversing about a theme of mutual interest (p.15). A conversational style can be facilitated by starting the interview, as suggested by King (1994, p.21), with a question that the interviewee can answer easily and without embarrassment or distress, leaving more difficult and sensitive questions until later on in the interview. Accordingly, I began most interviews by asking for a summary of the interviewee's qualifications and work experience. This was easily answered by most interviewees, but was more difficult for a few interviewees who had had many changes in employers or periods out of engineering employment.

During interviews where I used an interview guide, I normally allowed the interview to develop its own flow, asking questions from the guide when the interviewee raised the topic of the question. In some cases I would say that I wanted to ask a question on the topic that the interviewee had raised later on in the interview. This approach is consistent with Flick's (1998) argument that there must be permanent mediation between the course of the interview and the interview guide, as following the guide too closely can reduce openness and contextual information (p.94).

The need to steer the interview in a way that results in information of interest to the researcher, yet allowing the development of rapport and contextual information, means that interviews are tiring to conduct. King (1994) recommends a maximum of three hour-long interviews in any one day (p.34). On two occasions I had three interviews in one day, and on both occasions I felt very drained afterwards. I found pacing the collection of data was very important to becoming familiar with each interview, and to my ability to theoretically sample for pertinent data in future interviews. I found that becoming to know the contents of each interview well was important in facilitating the sub-conscious processes involved in research and was also useful for the recollection of data when writing memos.

Ethical concerns arise when using humans in research. I gained consent for the research from the University of Canterbury Human Ethics Committee. Traditional ethical concerns associated with interviewing revolve around the topics of informed consent, the right to privacy and protection from harm (Fontana and Frey, 1994). Involvement in my research was voluntary. Participants were given and asked to read an information sheet about the research project, and were then asked to sign a consent form prior to the interview. I updated the information sheet during the research due to changing my supervisors and to better reflect the current focus of the research. A copy of the consent form is provided in Appendix A, and copies of the information sheets in Appendix B. In the information sheets I explained that the interview could be audio-taped[7]. To ensure that participants were aware of this I used an obvious tape

[7] 35 of the 40 interviews were taped

recorder in person-to-person interviews, and reminded telephone interviewees at the start of the interview that I was taping the conversation.

To protect the confidentiality of participants I endeavoured to remove as much potentially identifying information from quotes as possible. Many of the engineers facilitated confidentiality by not referring to other people involved in a project by name, and by not naming companies or projects. Being of a similar age or younger than most of the participants I did not feel that I was in a position of power over interviewees. In fact I sometimes felt that I was being treated as a naïve young engineer who needed to be told the facts about real engineering. I did sometimes sense that interviewees were trying to impress me.

As mentioned earlier, I undertook repeat interviews with two participants, however I felt that I was taking too much of their time, and that it was more productive to direct my research efforts to interviewing new contacts. I felt that being sensitive to and respectful of interviewees' concerns was important to ethical interviewing. In two interviews the problems the interviewees had in dealing with managers whom they had worked for, overshadowed their concerns with difficult projects. In these cases I gave time to listen to their concerns rather than focusing solely on the interest in difficult projects. This approach, of acting interested in what people have to say, facilitates the development of rapport (Taylor and Bogdan, 1998, p.51).

As noted above, thirty-five of the interviews were audio taped, the exceptions being one impromptu telephone interview and the final four interviews. Telephone interviews were taped by using a speaker telephone. Glaser (1998) argues against taping interviews as it can undermine the willingness of people to tell the researcher what is really going on, despite assurances of confidentiality (p.111). Nevertheless all but one interviewee in my research appeared to be comfortable with being taped. As discussed above, some interviewees were careful not to actually name people, companies or projects, suggesting they were censoring what they said to some extent. There were times when I was surprised at quite how willing interviewees were to discuss difficulties they had encountered, and I felt that this put additional

responsibility on me to ensure all potentially identifying information be kept out of quotes. Interviewing people out of the hearing of other people and only interviewing a very small number of people from any one organisation was probably more important to the willingness of interviewees to talk freely than whether the interview was taped or not.

It is interesting to note that despite ensuring interviews conducted at the place of the participants work were in meeting rooms or private offices, I had the impression that, in general, participants interviewed at home (in person or via telephone) talked more freely than those interviewed at work. I had the impression in some of the interviews that the interviewee felt that the meeting room was not fully soundproof and therefore people walking past could possibly overhear some of our conversation.

Thirty-three of the interviews were either partially or fully transcribed. Notes were taken on the remaining seven interviews during and immediately after they were conducted. Partial transcriptions of interviews were undertaken for the earlier stages of the research. I would listen to the tape, taking notes on what was discussed, and transcribing only those quotations that seemed particularly important. This approach is appropriate where resources are not sufficient to permit full transcriptions of the data (Patton, 1980, p.248). I found that this approach significantly reduced the time taken to transcribe the interviews. Tapes from most interviews where an interview guide had been used were fully transcribed, however, sections of the transcriptions that were incomplete or uncertain due to poor tape quality were only used in the analysis with caution.

Glaser (1998) argues that transcribing adds unnecessary time to the research and slows the tempo of grounded theory, which can reduce motivation, and can result in unnecessary data: it slows the focusing of the research effort to theoretical relevance (Glaser 1998, p.108-109). I did have a sense of stalling when I had interviews that were being professionally transcribed as I did not have them on hand to analyse, and therefore alter my subsequent interviewing. When I had been transcribing interviews myself I did so very soon after the interview, and usually before the next interview, so

that I was able to promptly adjust the focus of the research. Full transcriptions were only taken in the later interviews when I had focused questions, and this reduced the amount of unnecessary data.

I found that taping, transcribing and note taking from interviews was important to enhancing my internalisation and memorisation of interviews. Internalising each interview was important to the pre-conscious processing of data, and thus taping and transcribing interviews helped rather than hindered this process. I also found that being able to incorporate quotes in the write up of the grounded theory added to my enjoyment writing. In addition, incorporating quotes demonstrates that concepts were generated from data. The last four interviews were not taped and I did find that by requesting that the interviewee give me time to write down some of the quotes I had more time to think about what to ask next and so I felt the interviews were more focused. While fully transcribing every interview is likely to inhibit the generation of theory, particularly if the researcher has to wait for transcriptions to occur, I think that some use of taping interviews and transcribing quotes can enhance the research process and the final write-up.

2.4.2.2 Documentation

The documentation used as data in the present study included the autobiographical style books about the New Zealand Ministry of Works (MOW), by the civil engineer and previous Commissioner of the MOW Robert Norman (1997) *"You can't win 'em all: confessions of a Public Works engineer"*, and the architect W. Frank Ponder (1996) *"A man from the ministry: tales of a New Zealand architect"*. Norman's book was particularly useful for developing an understanding of the history and context of New Zealand engineering. Ponder's description of his role in designing Scott Base, New Zealand's base in Antarctica was used as an example of involvement in a difficult project.

The third and main source of documentation used in this study was a report on the Opuha Dam Collapse by the Canterbury Regional Council's Rivers and Coastal Resources and Hazards Manager Mr. A. J. Boyle (1998), titled *"Opuha Dam Collapse: A Review"*. The Opuha Dam, located in South Canterbury New Zealand,

collapsed on the fifth of February 1997, when partially completed. The resultant wave of water and sediment inundated farmland, killing life-stock, wrecking fences and shelter-belts, flattening crops, removing topsoil and dumping boulders on fertile paddocks. It also reduced the ability of the Opuha and Opihi rivers to support fish and bird life. Boyle's report formed part of the Canterbury Regional Council's technical investigations relating to the Opuha Dam failure. The report reviews the documentation that was obtained from the parties involved in the design and construction of the Opuha Dam, in relation to the Canterbury Regional Council's prosecutions of the contractor, the project manager and the client. This report was chosen as a source of data because it comprises many extracts of communication between the different parties, including minutes of meetings, letters, memos and so on. The extracts provide data on the concerns of the various people involved in the project, and some of the ways that they went about dealing with their concerns. In the report Boyle discusses these extracts in relation to their relevance to the dam collapse, and his analysis facilitated my analysis. I obtained an electronic copy of this report and broke this into a number of smaller documents for ease of handling on the computer. Quotes from the report are referenced to these smaller documents, such as Opuha2.

2.4.3 Analysing the data

Developing a grounded theory is a chaotic, creative process. My experience of the process was of steadily reducing the extent to which I was forcing (influencing) the development of the theory, until I reached the point where I was comfortable that the emergent theory fitted and worked for the substantive area. This shows that the processes of grounded theory methodology are self-correcting, in that they reduce forcing by the researcher. I had the sense of steadily building up a bigger picture of how civil engineers cope with difficult projects, with many of the codes that were identified early in the analysis becoming incorporated into the theory as properties of higher level categories. Significant to my experience of undertaking the grounded theory was the development in my knowledge of social-psychological theory. This improved my theoretical sensitivity and hence my ability to interpret the data.

I provide a descriptive overview of the process of developing the grounded theory below. This is presented as a number of developing themes that approximates the chronological development of the theory. There was, however, considerable overlap in the development of the different themes. This occurred because at any one time I would be investigating a number of themes (theoretical sampling) that were pertinent to the theory at that time. The purpose of discussing these themes is to reveal the process of the research, showing that I became aware of different ways that I influenced the research, and indicating how I reduced this forcing.

The interview researcher can be likened to a traveler who goes on a journey, entering into conversations with the people in the landscape, exploring many parts of the country, sometimes deliberately seeking specific sites or topics, and returning home with a tale (Kvale, 1996, p.4). The tale is being constructed throughout the journey, not just at the end. Similarly the analysis of my research began within the first interview and continued throughout the research process. I began coding the interviews right from the start. My initial focus was on what engineers were doing, that is, on the practical problem-focused strategies engineers used to deal with projects. I used the computer program, Nudist®, to aid the handling of the data and codes. I would frequently sort the codes on Nudist® to find higher level categories. This quickly led to the codes *fitting* and *thumbs-upping* that later on became properties of the category *Frontier Building*[8].

An implicit assumption of my initial focus on ill-defined projects was that the problem for engineers was to do with characteristics of their projects. As discussed earlier, it soon became apparent that it was difficult projects that may or may not be ill-defined that concerned engineers, and from the tenth interview I shifted the focus to difficult projects. The reasons for projects being perceived as difficult by engineers lay not only in the characteristics of the projects, but also the characteristics of and relationships between the engineers, their projects and their social settings. The dominant reason that engineers found projects to be difficult was their lack of

[8] Frontier building is one of three main categories of the core category, and is the subject of Chapter Five.

precedent experience in coping with that type of project. However it was apparent that it was not only engineers' internal resources for coping that influenced project difficulty. The level of experience pertinent to the type of project held by relevant others (such as the client, other engineers, architects, contractors, consent authority staff, government departments) influenced the resources engineers could use in doing their work, and the ease with which they could get the thumbs up. Discussing these factors with engineers was also very useful to identifying other conditions that influenced how difficult engineers perceived their projects to be.

Early on in the research process I was struck by the extent to which engineers were emotionally aligned with how well their projects were going. This emotional alignment was apparent in engineers' descriptions of being involved in difficult projects, and was also indicated by their body language and verbal expression when discussing such involvement. However, I consciously decided not to ask engineers more about this emotional alignment in the early stages of the research. This decision can be seen as an example of forcing as I was restricting the investigation of the underlying common concern. Part of my reason for not investigating the emotional alignment lay with my self-identity as an engineer with my associated focus on the problem-focused strategies engineers use, and my lack of appreciation of the importance of socio-psychological theory to understanding peoples' concerns.

Another reason that I was reluctant to investigate the emotional alignment was because I was very ignorant of theory on emotions, and I thought it would be a huge task to read this literature. At that time I did not feel that I had the energy or the time to investigate this large area. In addition I was not very enamoured with the idea of interviewing engineers (some of whom were men much older than myself) about their emotions. One of my concerns was that engineers could be affronted if I gave a fairly benign information sheet and then started asking quite sensitive questions. With time I did adjust to the idea of interviewing engineers about their emotional alignment with projects. I altered the information sheet to indicate that I would be asking about emotions. I began asking about emotional alignment from the fifteenth interview, and soon became quite comfortable with asking such questions. In retrospect seeing

myself as an engineer and not a sociologist, and therefore not sampling for emotional aspects significantly slowed the speed with which my understanding of the engineers' common concern developed.

Fairly early on in my analysis I began using a staged process framework for analysing the data. This approach arose because it seemed to me that there were some parallels between a three-staged passage (Glaser and Strauss, 1971; Faulkner, 1973; Tinto, 1988; Kellehear, 1990) and engineers going through the process of being involved in a difficult project. I described the first stage of an engineer becoming involved in a project by the *sense of being thrown in the deep end.* Being thrown in the deep end was characterised by engineers feeling unsure of quite how to proceed and being worried or even excited about their involvement with a project. The second stage of the process was described by the code *getting through*, which involved engineers fulfilling their roles with respect to their projects. Getting through was the ongoing process of behaviours that (it was hoped) would result in them fulfilling their roles. The final stage of the process of being involved in a project was described by the code *gained experience*. Gained experience was a result of reflection by an engineer and others on the getting through process, and the resulting recognition that the engineer had shifted to a new and higher level of experience.

It was evident that engineers were concerned with their ability to cope with the wide range of situations presented by involvement in difficult projects. In effect their main concern was trying to do a good job, so I described the core category at this stage as *situational competence*. My increasing theoretical sensitivity, as a result of reading the social-psychological literature, further analysis of data and theoretical sampling revealed that engineers' performance in difficult projects reflected on their self-identity and their self-esteem. This helped to account for why engineers were emotionally aligned with their projects. The term *competence frontier* was eventually developed to incorporate these aspects of the central concern.

Meanwhile my understanding of how engineers went about coping with difficult projects continued to evolve. Three threads of ideas emerged to alter my view of the three staged process that I had been developing. One was the theory on cognitive

appraisal and coping (Lazarus and Folkman, 1984). Another was the criticism by Wilson and Hutchinson (1996, p.122) that grounded theorists need to move beyond the trivial stage process, typically characterised as getting in, getting on, doing it, finishing it, getting out and so on that many theorists develop, and which my theory was beginning to look like. And most importantly the theoretical sampling indicated that the three phases were not particularly distinct or necessarily always ordered and actually indicated different types of processes rather than phases

I had established that the self-evaluation and cognitive appraisal theories were of central relevance to the processes that were occurring as engineers dealt with their main concern. I went through a phase in which I was uncertain as to how much emphasis to place on this existing formal theory in the development of my grounded theory. Do I let the structure of existing theory govern the structure of the theory I am attempting to develop empirically? Glaser (1998) describes the awe that researchers feel toward literature as a source of forcing when they force the data to be consistent with or conform to that literature (p.87), and he emphasises that theories from the literature are for enhancing the researcher's sensitivity and they are not to be directly applied (p.83). I decided that while the existing theory could be used to help me interpret the data I really needed to capture the essence of what was occurring in my substantive area. While I expected my theory to generally be consistent with the formal theory, I needed to show the nature of how those processes occur in the civil engineering field. Further I needed to be open to my empirical study revealing differences to and extensions of the existing formal theory. While I knew these theories were relevant to my data I needed to refocus on my data.

Refocusing on the data lead to the identification of the in vivo code "*Have I done a good job?*", a process which incorporates the process described by self-evaluation theory. I also described this code as *frontier positioning*[9]. It is predominantly a reflective process, and results in the recognition of gained experience, the code I had identified earlier in the research. Much of the cognitive appraisal theory became couched within the *connecting-project-and-frontier*[10] process, which the in vivo code

[9] Frontier positioning is the subject of Chapter Six.
[10] Connecting-project-and-self is the subject of Chapter Seven.

"*taking ownership*" (of the project) indicates. Taking ownership is a concept that is significantly broader than the theory on cognitive appraisal, also relating to theory on job involvement. Taking ownership involves anticipation and contributes to the formation of emotions such as the sense of being thrown in the deep end, identified earlier. The getting through code identified early in the research became described as *frontier building*[11]. It emerged that these three processes are concurrent, inter-related and ongoing throughout involvement in a project, and account for the emotional involvement associated with projects.

During the analysis of the data I found it very useful to alternate between analysing the interviews and the documentation on the Opuha Dam project. On several occasions I found that a process that emerged from one type of data was also evident in the other type. For example I identified the process of *establishing expectations* when analysing the Opuha Dam documentation. Upon reanalysing interviews I found that establishing expectations was also evident in the interviews, despite my failure to identify this process when I first analysed the interviews. The use of different data sources is recognised as a way of facilitating the development of good qualitative research, and is known by the term data triangulation (Flick, 1998, p.68). I found that, as the interviews became more focused on investigating the emerging theory with the use of interview guides, Nudist® was less useful for collating data. Instead I used Microsoft Word® to collate data, and write "living memos" that changed as my understanding of the memo topic developed.

I have developed some thoughts and impressions on forcing as a result of undertaking the grounded theory study. One impression is that one's early attempts at developing concepts can appear retrospectively as forcing. For example one develops initial interpretations of just a few cases in the early research, but analysing further cases can reveal that the initial interpretations are rather limited. The initial interpretations nevertheless form an integral part of the process of building up the theory. This process of improving interpretation does, however, place great emphasis on the need to be prepared to re-conceptualise as new data indicates.

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[11] Frontier building is the subject of Chapter Five.

I found discussing the emerging concepts with research participants to be a very useful way of identifying the limitations of these concepts. If my emerging theory was not adequate, engineers appeared to be quite prepared to tell me so. This could be quite disheartening at times. However being uncomfortable with the ability of the emerging theory to account for all data was important to motivating me to continue to develop the theory until I reached the point where I was comfortable. Knowing the data very well was important to having confidence in these feelings.

The grounded theory process is normally described as open coding until the core category is chosen, and then the researcher switches to selective coding. However, I did not experience a clear transition between open and selective coding. Instead I experienced an evolving understanding of the many properties of the underlying problem and the associated resolving of that concern. The final identification of the core category only occurred after many of its properties had already emerged.

2.5 Summary

In this chapter the grounded theory method was described, including the emergence of three different approaches to the method. These approaches were discussed in relation to ontological and epistemological assumptions, and my experience of undertaking grounded theory research.

The sources and processes of collecting data for the present study were described. Description of the development of important threads in the analysis of data and the development of theory revealed that, when viewed retrospectively, forcing occurred in several ways. I found that my own self-identity and my associated thoughts on my role in the research significantly delayed the identification of the common concern. I also found that I had to be very conscious of the appropriate role of existing theory in relation to my research: grounded theory research should be informed by but not subservient to existing theory. Continued use of the grounded theory method reduced the level of forcing to the point where the developed theory accounts for much of

engineers' experiences of being involved in difficult projects. Description of the common underlying concern with difficult projects is introduced in the next chapter.

Chapter 3
Project difficulty and the underlying common concern

3.1 Introduction

An understanding of the participants' underlying common concern is critical to the development of a grounded theory. In the present study I developed an increasing depth of understanding about why projects are difficult, and hence about engineers' underlying common concern with such projects, which involves the relationship between engineers' competence and their projects. The present chapter begins with a description of the more obvious features of project involvement that are perceived to contribute to the difficulty of projects, before proceeding to describe the common concern that underlies these features. There are a number of aspects to this common concern, which are presented because of their importance to the core category[12] and its properties, which form the subjects of the following chapters.

3.2 What makes projects difficult?

I identified the features that contribute to project difficulty by comparing different projects described by engineers, and by discussing with engineers, the factors that make projects difficult and the factors that contribute to stress. In addition, understanding the conditions that influenced engineers' abilities to cope with project involvement contributed to my understanding of why projects can be difficult. Thus the concepts of "stress" and "coping" are associated with the topic of "difficult projects".

Definitions of coping and stress both involve a person's capacity to respond to a situation being challenged. For example, a widely accepted definition of stress is "a (perceived) substantial imbalance between demand and response capacity, under conditions where failure to meet demand has important (perceived) consequences"

[12] The "core category" is the overriding concept that integrates the whole of the grounded theory, and accounts for the research participants resolving or processing their common concern. In the present study the core category is engineers' competence frontiers.

(Gowler and Legge, 1980, p.213). Similarly, coping is defined as "constantly changing cognitive and behavioral efforts to manage specific external and/or internal demands that are appraised as taxing or exceeding the resources of the person" (Lazarus and Folkman, 1984, p.141). Thus difficult projects are those that are difficult to engineers as individuals, for any reasons that tax or exceed their abilities to cope.

In each project a number of different factors can combine to influence the difficulty of the project, as illustrated by the following quote.

> There are a range of reasons for (some) projects being more harder than others. Some of them are dead simple. Technically there is not a hell of a lot involved, you are using tried methods and you know to use people who have an established degree of competence on them. Other ones, where there is a combination of raising the client's expectations when we put the tender in, and an ill-defined brief, and expectations of clients, and 'hell we don't really have people who have the competence even though we said we have', and 'my God they have given us the job!', 'well how are we going to do it?' And some of those can be quite complex and it is a combination I guess of technical issues, briefing issues, expectations with respect to timing and clients' budgets, because that can make some jobs quite difficult.

Many of the features of project involvement vary with each engineer, employment setting and individual project. That is, they are variables that may change from one project to another, and may also change during the life of a single project. These features act as mediating conditions on the processes involved in the core category, and they are discussed where appropriate in Chapters Five, Six and Seven. Their identification was important to understanding the common concern of the research participants, and the associated core category. It is therefore appropriate that these features of project involvement be introduced to the reader here. The features presented here are by no means a complete list of all those factors that tend to be associated with project difficulty; they are, however, the factors that were frequently discussed as important by participants.

The features have been categorised as the *experience relevancy*, *nature and history of relations*, *support situation*, *project set-up and project characteristics*, and the *characteristics of the engineer*.

3.2.1 Experience relevancy

The most common feature that influences how difficult an engineer will find a project is the engineer's *experience relevancy*. The extent of experience relevancy arises from the fit between engineers' experience and the demands placed on their competence by project involvement. Low experience relevancy occurs when an engineer has a low level of experience relevant to the demands of a project, that is, the engineer lacks precedent experience. High experience relevancy occurs when an engineer has undertaken similar projects before.

Engineers with low experience relevancy usually need to spend more time and effort in fulfilling their roles in the project. They are likely to be apprehensive about their ability to do the work, that is, they have the sense of being thrown in the deep end. In effect they have a low level of personal resources for dealing with the situations presented by their projects.

> Most of the time it's that I don't know anything about what I'm doing.

> I guess basically there are probably a number of factors that would make something more challenging. The first would be my experience. That I have any experience with the job or whether I have done that type of work before and whether it is easy for me or I have got to learn a lot of the stuff as I go through the job, which tends to slow you down.

With low experience relevancy more time must be spent gathering, understanding and applying information. The additional time that engineers spend on their projects may not meet the expectations of their clients or their employers and this can contribute to making them feel incompetent. In the following quote the engineer describes low experience relevancy as a factor that contributed to making a project difficult because of the additional time it took.

> I think the third thing (that made the project difficult) was that I am not actually a specialised (type of civil engineer) so there was ah, just a bit unfamiliar with the design side of things as well. You have got a general idea of how the design should go and what sort of elements you are dealing with. But it does just take you probably 30% to 50% longer just to actually go through the design than it would for an experienced person who does it every three or four weeks. So technically easy design, but you still have to familiarise yourself with it and all the elements of it.

A high level of experience relevancy, on the other hand, is likely to contribute to a project being easy.

> For some time I have been able to answer most of the questions that arise. I have been in (the area of my speciality) for long enough now to. I think it would take a major difficulty for something to really surprise me.

Although the experience relevancy of engineers is important to how difficult they find their projects, the *experience relevancy of the other people* who are involved in those projects is also very important. These other people may include engineers' co-workers, the client, contractor, consultant engineers, architects, scientific experts, consent authority staff, public servants in national government departments, the tangata whenua (the local indigenous tribe who have customary authority in an identified area (New Zealand Government, 1994)) and the public.

If an engineer lacks experience relevancy, but the relevant others are experienced, then all the engineer has to do is try to learn from those more experienced people. This can be easier said than done, as more experienced engineers may be unable or unwilling to spend the time to help the less experienced engineer. This can be quite a significant and common problem for inexperienced engineers.

> It was getting to grips with the codes. (My previous employer's) environment wasn't particularly supportive. You tended to have to find your own way. At the time I didn't feel there was much support around. There were a lot of experienced engineers in the office but they tended to be busy with their own work and the last thing they wanted to do was to skill up an under-grad.

Projects where an engineer and the relevant others both have relevant experience tend to go smoothly.

> It is great working with people that have been with you for five or ten years and have done projects and they know the way you think and they have also seen the mistakes that have been made on other projects.

Projects where an engineer has relevant experience, but the others don't, are characterised by the engineer educating others on what should be done. Such situations can become extremely frustrating for engineers if the relevant others are in a position of power where they can ignore the engineer's advice.

> We said, 'this is not the way to do it, it is going to be a disaster, you have never worked this before, you have to develop the (equipment) first, then you have to go and (do the work).'... ...But they wouldn't listen to any of our advice on what to do at all. The thing came to a sad end. They achieved nothing, but spent a huge sum of money.

The most difficult projects tend to be those where neither the engineer nor the relevant others have relevant experience. The engineer often has to contact people or

organisations new to him or her. People are often reluctant to make decisions that are necessary for the engineer's information, or to approve the engineer's proposed approach to the project development. These projects tend to go round and round as people fail to commit to decisions. Such projects tend to occur in novel situations or when new legislation or codes are introduced.

> The technicalities still went around in circles a number of times. It was probably the most difficult report I have ever had to write and bring together... ...so you have got people who you would normally rely on to provide the technical standards necessary to protect the health and welfare of the country going, 'ahhhh, we don't know', which didn't help.

The extent of experience relevancy of the engineer and others is often associated with the nature and history of relations between the engineer and those others.

3.2.2 Nature and history of relations

The nature of, and extent to which relations are established between the different people and organisations involved in projects form an important influence on how well those projects go, and how stressful engineers find them. When people trust each other through shared experiences and confidence in each other's ability, projects tend to go very smoothly.

> Once you know someone on a personal level it is so much easier to work with them on a professional level.

> Because of the remote location everyone knows everyone else and this helps to make the job run more smoothly.

New relationships can be characterised by uncertainty and mistrust, making it difficult for engineers to gain the necessary approval from relevant people, and to know whom to contact for information. For example a structural engineer new to high rise design can have a much more difficult time getting building consents from council staff than engineers who the council staff already know and consider to be competent.

In the following quote the engineer emphasises both certainty and rapport as important, but also notes the establishment of communication lines. Structuring of communication lines occurs during the project set-up, which is discussed in Section 3.2.4.

> If you are working with someone you have worked with before you have got good rapport, you know what they expect, you know what sort of work they are going to generate. They tend to be the ones (projects) that are fine. It's the ones (projects) when you are working with someone new where you don't have good rapport, don't have good lines of communication or if you don't have good direct contact with the client (that are difficult).

Projects that are controversial and have a high level of input from the public, can increase engineers concerns with developing and maintaining competence, and can be very stressful.

> The other (type of project that is difficult) is where you are dealing with a controversial thing, like siting of a (Not-In-My-Back-Yard type of project) and you have got public consultation ongoing, that is very stressful because you have got a lot of people who are upset and they do get very upset and I have been through that exercise when I was at (a district), (a number of) years ago and some people were losing sleep themselves with the thought of this. A lot of it is perceived, and once they get banded together and you face a hall with 200 hostile people, yeah it is a pretty difficult situation.

The extent of *power or influence* engineers have over other people who are involved in their projects can influence how frustrating they find project involvement. The structure of contracts or arrangements between an engineer and people who are external to the engineer's employer can influence the ability of that engineer to get those people to have desirable input to the project. In this next quote the engineer's advice is ignored, and he does not have the authority to enforce it.

> The site supervisor was the one who actually got things done, he was very sensible, very good. He agreed with the need to (carry out a testing procedure), but the assistant project manager overruled that because he wanted to save money... ...You can't force him to do it, it's his decision at the end of it... ...It was notable (the project) for a number of things where you say, 'you shouldn't do this, this is what you should do, this is how you do these things'. They just, you know, reject the advice.

Getting people within the engineer's employment organisation to contribute in the desired way can also be difficult.

> I do feel a bit disappointed if things don't come out quite properly and I get particularly pissed off with people who haven't done what has been basically laid out as instructions or designs for them to do. But actually tracking down those responsible and dealing with them is really hard in this organisation.
>
> Not many of them come in and work the weekend. It's a very 8.30 to 5.00 mentality that they have. Now I can't break that. I don't have the authority to break that, but they know that I do the talk.

3.2.3 Support situation

Engineers' *support situations* are important to their abilities to cope with stress, to fulfil their roles with their projects and to the process of appraising their competence. It is well established in the literature that social support is important to reducing job stress (e.g. French, Caplan and van Harrison, (1982)). Engineers' families, colleagues and employment organisations are important to this support situation. The following quotes emphasise the importance of support situations.

> I felt really isolated, so I think probably I find I feel a lot happier working on projects where I know I have got access to experience if I need it... ...I tend to find if I know there are other people I can ask for help, it makes it much easier. I have got somebody to bounce ideas off, someone to check that I am heading in the right direction.

> What really makes it quite easy is there are so many people working in this building in my area, and there is almost always someone that I can ask, if I am lacking skills in particular areas.

The continuity of support staff is important to engineers' support situations. This is consistent with the importance of the experience relevancy of relevant others.

> Sufficient support staff, who are experienced enough, who can answer effectively and having continuity of staff is always the biggest issue in our firm. You know we train up younger engineers and they either decide to go back and do post-grad type work, and others decide to go overseas.

While access to practical support is important, the culture of engineers' workplaces can significantly influence how stressful they find their work. For example, organisations with very high expectations can make engineers feel unsupported and incompetent.

> You might actually be a reasonable engineer, but you are feeling as though you are a shitty engineer, which is because (my employer) put such a high emphasis on performance... ...I mean there is a real arrogance to it and I think it sort of shows itself internally in that they put a lot of pressure on people. It is not necessarily a sort of nurturing environment, if you know what I mean.

Spouses of engineers were often described as a particularly important source of support for dealing with both the practical problems and the emotional strains of work.

> If I was someone without a husband it would have been more difficult because I wouldn't have had someone to pour all the problems out to that wasn't part of (my workplace). So that was a necessary stress relief. Very necessary part of it. I think there are a lot of people who don't realise that you need that release valve. Especially a lot of men who haven't realised that it's alright to throw a temper tantrum at home. That is needed. That

> you don't have to be calm cool and collected forever. Maybe that's why they get lots of ulcers.
>
> I go home at the end of the day and rail about things that have gone wrong... ...My wife is a sounding board sometimes if I want an opinion on how to tackle something, problems with people at work. So you do pull on all your resources.

The extent of support available to engineers can be influenced by the way in which projects are set-up. Discussion of aspects of the project set-up and characteristics of the project that are important to project difficulty follow.

3.2.4 Project set-up and project characteristics

The manner in which *projects are set-up* and the characteristics of the projects can significantly influence how well they go and the engineers' levels of stress. The project set-up defines many of the features of the relationship between projects and engineers. It can define the expectations of engineers' performance and the associated resources they can use, the procedures they must follow, and the level of responsibility they hold. Engineers often become involved in projects when those projects have already been going for some time, and so the project history and the circumstances of becoming involved in projects are also important. In addition the nature and frequency of problems arising influences how difficult projects are perceived to be. Discussions of these features of project involvement follow.

3.2.4.1 Expectations: performance and resources

In addition to organisational culture influencing the level of expectations engineers feel, project set-up can also define the expectations of engineers' performance, including the constraints they need to meet or work within. These constraints often involve limits on the resources they can use (i.e. project budget) and the amount of time that can be spent on their projects. It is well established that the resources individuals can use to cope with difficult situations influence how they appraise those situations, and how they cope with them (see for example Terry, Tonge and Callan, 1995). The following quotes emphasise the importance of expectations of performance and the associated constraints, to project difficulty.

> ...but it is just probably meeting some quite tight deadlines, just conflicts with other projects, just having enough time to get on with these and people and sufficient support staff who are experienced enough.

> Upgrading of existing plants is that much more difficult because you just can't start with a green field and lay things out as you want. You are always battling to fit this thing in here, and if you put that there you can't put something else there, and it really is a jig saw puzzle. And you have got to have a lot of mental flexibility to see ways around just the space limitation and also keep your costs under control...
>
> ...in the end that became quite difficult because the client wanted to have everything out to contract so it could be built in the 1998-99 financial year which ended in June. So there was a lot of pressure to get contract documents produced by a certain date and the client was also very price sensitive so the budget was low, the tight programme, so there were those constraints as well, which adds to the stress level.

A lack of resources can be difficult for engineers because it sets high expectations on their efficiency and it can require them to produce work that they do not think is to a high enough standard. In effect, their personal values are violated and this can be a significant source of vocational stress (Burke, 1988), and can make people feel guilty and then angry with themselves and their work organisations (Levinson, 1980). For example, in a particularly emotional interview in the present study an engineer described work experience in which she was asked to write a report making incorrect conclusions about the analysis of poor quality data[13]. She coped with this by wording the report so that the readers could see the details of the analysis (and hence the poor quality of the data) for themselves, even though she still gave the conclusions that her boss desired. She did find those expectations very difficult and they contributed to her intention to leave her employer. Similarly, in the next quote the engineer describes how some engineers cope with expectations for work to be done with a low level of resources by insisting on doing what they consider to be an acceptable job. They cope by using more time than has been allocated.

> The old hands that have been around for years... ...they have already decided how they are going to do the job and how they are going to manage it and how they are going to do their bit, irrespective of you telling them, 'no that is not what we want, the client only wants this amount of money spent'. They have already got in their mind that they are going to do it that way anyway, because that is the way it has always been done. And in actual fact for them to do less is technically unacceptable to them because professionally (they) wouldn't be comfortable.

A lack of time, or resource constraints in terms of limited useful data means that engineers often need to make assumptions. The need to make assumptions can be of concern to engineers.

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[13] This was not a New Zealand employer.

> Quite often we get projects with a very short turnaround, might want something by 10 o'clock the next day - larger projects you get a week to do - which means you are under a lot of pressure to do them, and you can make a lot of assumptions rather than sit down and do - got time to sit down and do quite detailed work.
>
> It's usually that lack of input data that is the problem, that's what I find... ...You can't reach a barrier and then say just, 'right I'm giving up'. Well you can but if you choose not to, all you need to do is basically acknowledge the errors, the error in your answer at that particular step along the way.

Expectations can also arise from the procedures and contracts that are set-up for the project.

3.2.4.2 Procedure and contract suitability

Contracts and procedures established during project set-up significantly influence how the engineers must go about their work, how they can communicate with different organisations, and ultimately how well their projects go. Engineers become very frustrated when inappropriate contracts or procedures have been established for a project. This can contribute to them having to waste time through rework, or can present difficulties in getting decisions made. An engineer's inability to do anything about the historical set-up of the project contributes to this frustration. The frustration reflects the fact that influences external to the engineer's control can affect the project performance and/or the engineer's performance. The project set-up can influence the lines or manner in which engineers can communicate with people involved in their projects. In the following quote the project set-up required the engineer to speak to tenderers individually and she fears this may have restricted her ability to do her work well.

> I would have loved to get them all in one room and talk to them at once instead of saying the same thing five times, and running the risk of telling one of them something in a different way I may have told another one, even if the information was the same.

In the next quote the engineer attributes the difficulties of a project to the process by which different groups of people worked on the project.

> ...it was really the old way of doing things which involved putting together projects by what I call the 'sausage factory method', that initially you send your surveyors out and then you send out your laboratories and geo-technical people, then your designers get involved with it and finally it is all packed over to somebody else that is responsible for putting together the contract documentation. Now that is a recipe for disaster. What is increasingly happening - what I have been trying to facilitate here, is that we work as teams, right through the whole project and there is involvement

> of a range of staff right through from the project inception to the completion.

Both the support situation and the project procedures can influence the nature and amount of *check-ups* associated with engineers' work. This is a condition that influences how concerned engineers are about their work. In general the more frequent and the better the check-ups, the less concerned engineers are about their work. Even though the more checks there are the more potential feedback engineers may get, this is actually of less concern to them than the fear of more serious feedback that may occur at a later point in time. Serious feedback could include for example, an engineer's work being identified as inadequate by people outside the employment organisation, or more critically the project could end up having adverse impacts on others, such as a structure that collapses and harms people.

> I guess the other thing is the level of verification that was done, so whatever you did you knew it was being absolutely thoroughly checked before it went out of the office into a contract document. So that gives you quite a feeling of security as well, because if you make an error, the chances are it is going to be picked up. So although you do everything you can to make sure your work is perfect, there is not the same stress level as you being the one who writes everything and it gets sent to the contractor and if it doesn't work it comes back to you, and it is your fault.

While in general the checkups provide engineers with security that their work will not result in serious failures, check-ups can provide opportunities for criticism of the engineer's work and dealing with this can be stressful.

> The peer reviewers all have different interests and some challenge you quite hard, and I'm not sure whether everybody is quite professional about their type of criticism.

3.2.4.3 Responsibility

Engineers' levels of responsibility for projects can influence perceptions of project difficulty. On one hand, if engineers have a low level of responsibility they can find projects frustrating because they have little autonomy and have to get the approval of others and they may have little direct contact with clients, so their work can be tedious and involve considerable rework. On the other hand, higher levels of responsibility can increase engineers' perceptions of project difficulty and fear of failure. There are three reasons why a high level of responsibility can make projects difficult. Firstly, as engineers become more responsible for a particular job, they can appraise a higher risk of being seen to be incompetent, and this is discussed in

Chapter Seven. Secondly, as engineers' responsibility increases they tend to become more responsible for factors that they do not have complete control over, such as other people. Even if an engineer is not responsible for those factors, if they affect the performance of the project then the engineer's reputation may be implicated. This is consistent with the theory that having responsibility for other people is an important potential source of stress (Cooper, 1991). Thirdly, as engineers gain in responsibility, they become involved in projects in the earlier stages of development, which can be more difficult.

> The projects (I was involved with early in my career) had a range of minor day to day problems, they tended to go pretty well which may be due to the problems being solved in the early parts of design by the other engineers. As your career develops you take on jobs at an earlier stage and for that reason you become unstuck.

3.2.4.4 Project history and circumstances of becoming involved

As previously noted, the history of a project prior to an engineer's involvement can significantly influence how difficult the project is. A project may be well established prior to the engineer's involvement, with the conceptual design work complete and the management systems well set-up. If such a project has been going well then it can be easy for an engineer to undertake his or her role with the project. The project may already have well established relations and a good support structure.

> ...they just pulled me into the team and because there was already a very strong management structure for the project, because it was such a huge project and it had been going for a while, and because there were already people who knew what was happening, it wasn't like starting from scratch. That was just a sweet easy thing to do, you know, it was almost walk in there with your eyes closed. So a lot of the - I guess it is because a lot of the tough scoping work and the initial work has been done. If you come into a project like that, it is always – well - it is often going to be a lot smoother.

On the other hand engineers can become involved in or become responsible for projects that have not gone well. Relationships between people may have already turned sour and it may be quite a challenge to get such a project back into shape.

> ...what I walked into here (a number of) years ago, I took up the position and it was an absolute shambles - that there were a large number of projects which had gone horribly wrong... ...it is your company, you are assuming responsibility for that and yeah it is emotionally very draining.

If an engineer becomes involved because another engineer has left, or is leaving the project, then how well the incoming engineer is informed about the project can influence how difficult he or she perceives the project to be.

> There's one job I'm working on right at the moment, which is a relatively frustrating job because I wasn't involved at the start so it was pretty much dumped on me to do.
>
> I was taking over from a guy who left within two weeks of me arriving, and he was not particularly good at continuity, so I was picking up things where there was very little information to pick stuff up, so that's sort've made it a bit more puzzling too.

Being able to choose projects may influence the level of interest and emotional involvement that engineers have with their projects. For example engineers who can be involved in a project from its inception may be more emotionally involved and gain more satisfaction from the project than if they were just allocated to a small part of a project. For example, the following engineer says:

> Mostly I have been able to choose what I have been involved in and that has probably contributed to why I feel very, why I (genuinely/generally) look forward to this job each day.

3.2.4.5 Relevance of the project to the engineer

The relevance of projects to individual engineers affects the level of satisfaction that they gain from those projects. A project is often perceived to be relevant to an engineer if it is expected to enhance the engineer's competence.

> Anna explains engineers are tending to talk about projects where they are thrown in the deep end. The engineer says, 'I love that: I love the challenge'. He could see himself staying in (his field of engineering) because there are so many unexplored areas. (Interview notes).
>
> I'm inclined to smile and say 'ooh this is a good one'... ...Difficult to me means challenging, it's fun, exciting... ...It's the difficult projects that you learn the most from. Where there are technical or human difficulties, those are the projects you learn from. Difficult projects give you valuable experience, more valuable than simple projects.

Some projects or stages of project involvement are difficult because it is hard to maintain motivation. In effect, engineers do not expect to gain much competence from these projects or from those stages of project involvement. That is, they know and are familiar with what needs to be done and just need to get on and do it. This time of having difficulty maintaining motivation was described by the term "grind".

> I guess some projects are more of a grind, they're not as interesting so you don't get the same level of satisfaction out of those.
>
> Then comes the hard grind of actually working through the process issues point by point to end up with a point where I can wrap it up.

There is a range of factors which influence engineers getting similar sort of work for long periods. One is that once an engineer becomes competent in a particular field, he or she becomes more efficient and therefore the employer likes the engineer to stay in that field to make the company more money. Another factor is the development of specialised project management companies that manage projects and get engineering firms to do the more detailed design. A third factor is that more experienced engineers in a firm may be reluctant to let younger engineers be heavily involved in difficult projects – the experienced engineers want to keep such interesting projects for themselves.

3.2.4.6 Problems arising

Projects can often become difficult because unanticipated problems, or problems thought unlikely to occur, do arise. Some of these problems can be rectified fairly easily, but many problems will result in engineers needing to gain competence to fix them. The uncertainty about what problems may arise can also be difficult.

> You could repeat these sort of mistakes in any country. I've seen examples in NZ where people have been into (this type of civil engineering) work, and it's harder than normal engineering contracts. You just don't know what's going to happen.

The physical nature of engineering projects contributes to the likelihood of novel or unforeseen problems arising. Some of the physical systems that engineers work with are rather like living entities, such as sewage systems or rivers. These systems can change their behaviour over short periods of time creating significant problems that need urgent fixing. The nature of the physical landscape in New Zealand and the low level of resources that have been available to engineers have created a considerable demand for innovative engineering (Norman, 1997). A low level of resources often means that limited geotechnical investigations are undertaken and this can result in problems arising later on in projects.

> You can have lots of unexpected site conditions. I think that's probably the major problem. with (my field of engineering), trying to estimate the ground condition.

Assumptions engineers make about the performance of other people who are involved in their projects can also contribute to problems arising.

> Some of the problems I would never have imagined that we had. The (construction equipment) not being in the right position: it would never occur to me that someone would make such a mess.

In summary, characteristics of a project and its set-up that influence an engineer's perception of difficulty include: the expectations in terms of the performance and the level of resources, the suitability of the procedures and the contracts to the project, the engineer's level of responsibility, the history of the project and the circumstances in which the engineer became involved, the relevance of the project to the engineer, and whether there were unexpected problems arising. These features tend to involve the relationship between the engineer and the project. I now address the influence that characteristics of engineers can have.

3.2.5 Characteristics of Engineers

Existing literature shows that personality variables are important to coping with stress (Payne, 1988). For example, a study of project engineers found that the tendency to focus on what is wrong or can go wrong, and the tendency not to attribute successes to one's competence were significant predictors of job-related stress symptoms (Thomas and Tymon, 1995). It is the nature of grounded theory studies, however, that characteristics of people do not become strongly evident as conditions that influence the core processes. This is partly due to the small number of people who form the data source, relative to that required for statistical significance. Further, in terms of the present study, while engineers are easily able to provide data on the influence of the characteristics of projects and social settings on the difficulty of projects because they have many to compare, personality traits tend to be fairly stable and so engineers can only compare themselves to other people. In addition, one needs to know of one's personality traits in order to comment on their influence.

I did develop a few general impressions of different personal characteristics that appeared to influence how difficult engineers perceived projects to be and how they coped with such projects, and I will outline these impressions here, for interest.

Young engineers tend to have a narrower range of coping skills than older engineers. Young engineers are less confident, and more concerned with their competence. This impression should, however, be treated with caution as Hall and Mansfield's (1975) study of engineers and scientists found little evidence of changes to needs such as esteem, autonomy, self-actualisation and self-image variables such as competence,

with age. In addition, in my study there were a few older engineers who had a high level of distress and comparatively few apparent skills for coping with stress. Further, there were a few young engineers in good support situations, who seemed to be confident and to have good skills at coping with stress. While the support situation may have played a role here, their confidence and ability to cope with stress may also have been influenced by their personality. For example, the young (male) engineer, in the following quote has a personal philosophy of not getting too emotionally involved and stressed with his work.

> But I suppose so long as my personal philosophy on life is that I try not to dwell too much in the past. If it's gone bad, can't do anything particularly about fixing it up, so you just learn from it and move on to the next one.

At one stage during the research process I had the impression that women engineers tended to be less confident and more concerned with their competence than male engineers. The following quote, for example, is from a woman engineer expressing her lack of confidence.

> I think a lot of my problems are people problems but it's also confidence. If I was confident most of these crises wouldn't be crises and that is something that will come with experience. Like when I started out I wasn't even sure if I was capable of being an engineer and there was a lot of that sort of fear.

While this is a possibility it may also have been influenced by many of the women I interviewed being comparatively young, as upon further questioning some of the men expressed their lack of confidence when they were younger.

Engineers' career goals, and the importance of their projects to those goals can be important to how stressful engineers find project involvement to be.

> I'm aware of a few goals that I've got. I don't want to make any mistakes and I don't. I put high standards on myself in order to move as fast as I can forward, and that's one of the reasons why I picked the company that I'm with because I knew they would be challenging. I could have gone with someone who nurtured me a bit more, but I decided to go with the scarier people because basically it's a faster track, I think. I decided to take the challenge.

While recognising that stable personality traits influence stress, my study focuses on the processes that engineers use for coping. Many of these processes involve skills that engineers learn. This suggests that by learning such skills engineers could moderate the influence of personality variables.

3.2.6 Conclusions

In conclusion, the difficulties with projects lie in the characteristics of, and the inter-relationships between, engineers, their projects and their social settings (these are subsequently referred to as the features of project involvement). This finding reflects a more holistic understanding of behaviour than my early research focus on ill-defined projects, as described in the previous chapter, which involved an inherent assumption that it is the characteristics of projects that are of concern.

A shift to a more holistic understanding of organisational behaviour has also occurred in the development of theory on human performance, which has commonly been considered only in terms of the influence individuals have on their performance (Ripley, 1999a). This perspective typically assumed that performance is a function of ability multiplied by motivation (Hellriegal, Slocum, and Woodman (1995) in (Ripley, 1999b)). Blumberg and Pringle (1982) attacked the assumption that performance was only a function of the individual's ability (capability) and motivation (willingness), advocating that the individual's opportunity for performance was also important. The opportunity for performance can be considered a work environment factor. Since Blumberg and Pringle's work a number of authors have confirmed that work environment factors significantly affect work behaviour and performance (Ripley, 1999b). Central to the main concern of engineers in undertaking a difficult project is their performance. The features of project involvement influence engineers' ability, motivation and opportunity for performance. Thus this study of engineers' involvement in difficult projects reflects a holistic understanding of human performance.

The preceding discussion of features that influence the difficulty of project involvement is a loose aggregate of interrelated factors. They reflect the conscious, fairly obvious factors that engineers identify with project difficulty. While these factors are interesting in themselves, the goal of a grounded theory is to find a common concern in order that an integrated theory that accounts for the greatest variation in behaviour can emerge. The underlying common concern will now be discussed.

3.3 The underlying common concern

Concern with competence is interwoven, sometimes implicitly, sometimes explicitly, throughout the features of project involvement that engineers associate with project difficulty (discussed above). Engineers are motivated to enhance their competence, and this is achieved on a day-to-day basis primarily through project involvement. While engineers need to continue to enhance their competence, it is also important not to practice too far beyond their current competence. When engineers work with borderline competence there is greater risk of incompetence, which may have consequences for the engineer and others affected by the project. Accordingly engineers have a dual concern about effects of the project, that is, concern for the self and concern for others. Project involvement is important not only for the advancement of engineers' competence, but also for the perceptions of engineers' competence. Engineers are often concerned that other people think that poor performance in a project is due to lack of competence in the engineer. These aspects of the common concern will now be discussed further.

3.3.1 The concern with competence

For engineers it is the competence they must demonstrate in order to do a good job with the project that is important, rather than competence as a perceived underlying stable characteristic such as intelligence. That is, it is not inherent competence, but performed or demonstrated competence in the situations faced by the engineer that is considered important. I term this *performed situational competence*, and discuss it further in Chapter Four. The involvement in, and the performance of, projects are central to engineers' establishment and maintenance of competence. The concept of competence used in this study incorporates the range of coping abilities that engineers use in their involvement with projects, which are evident in Chapters Five, Six and Seven. Broadly speaking, competence includes not only technical competence, but also, managerial, relational (Fletcher, 1999) and stress management types of competence.

The aforementioned features of project involvement influence the difficulty of projects by impeding or enhancing both engineers' ability to fulfill their roles with their projects, and the projects' performance. In addition, they influence how

engineers perceive the relationship between project performance and their competence, and their ability to cope psychologically with the demands presented by projects. For example, the resources that are available to an engineer, as defined by the project set-up and the support situation, affect the engineer's ability to cope both practically and psychologically with difficulties presented by the project. The experience relevancy reflects the fit between the engineer's competence and the demands of the project. The project history and the procedure and contract suitability affects the extent to which factors external to engineers' control enhance or hinder project performance. The experience relevancy, expectations of performance and the relevance of projects to engineers influences engineers' perceptions of the relationships between project performance and their competence. Characteristics of engineers, such as their internal resources for coping psychologically with stressful situations are also important to their perceived and actual competence in coping with project difficulty.

3.3.2 Motivation to enhance competence

It is through day-to-day involvement in engineering projects that engineers act out their competence and gain information that indicates how competent they are. That is, engineers develop and assess their own competence through their involvement with projects. Engineers are motivated to enhance their competence both because it is necessary to the ability to fulfill their roles with projects, and because of the rewards that are associated with enhancing competence. In the following quote the engineer discusses how he is motivated to enhance his competence because he has influence over the project and is able to claim some credit for the results.

> I think that the first motivator (for enhancing my competence) is - that is for any engineer - that there is a control issue involved in it. And that if you are doing a job - to be involved in it, to have some element of control over it, and to end up seeing results and to a certain degree claim some credit for them - it is a very strong motivator. And that is one of the things that has been driving me here, is that I can do some work, follow it as far through as the process within (my employer) allows before I hand it on to somebody else and then ended up seeing the (finished product). And that is quite satisfying, and then to have that positively acknowledged is very satisfying as well.

3.3.3 The importance of project involvement to enhancing competence

This study has focused on engineers' involvement with projects. Being involved in projects, however, is not the only way that engineers gain and display their competence. Engineers may play out their competence through having organisational responsibility or through involvement with and recognition by the profession. Engineers can also gain competence by reading journals, attending conferences or educational meetings of interested engineers or through observing the mistakes of other engineers. Nevertheless project involvement is the dominant day-to-day mode of gaining and establishing competence for many engineers.

In New Zealand there is a tendency for engineering firms to have relatively flat organisational structures, and so the assessment of competence by promotion through organisational hierarchies occurs infrequently and is not an important day-to-day issue. Similarly, recognition by the profession through the registration process, and hierarchies of professional membership do not occur with regular day-to-day frequency, although they can be very important to engineers at times. A consequence of flat organisational structures is that even when engineers become managers they often continue to remain involved in projects, and assess their performance, at least in part, on the basis of those projects, even if they are not doing the design work on those projects. For example, an engineer interviewed in the present study understood that a manager of a section in a large consultancy reviewed practically every report that came out of that section.

In part the importance of project involvement occurs because, in the New Zealand setting, most engineers have a significant influence on the projects they are involved with. That is, there are few engineers involved in most projects and so the project performance is seen as indicative of each engineer's competence. The following quote emphasises the small number of engineers involved in each project.

> I think you have to be (involved in) a pretty big job with a pretty big company, to have more than one person at your level doing work. I don't think there are probably that many around in the roading industry, things like that. Like that motorway extension type work is likely to involve that sort of areas of level of responsibility with several people on each of those levels. But a lot of the work that we do is seal widening or what they call

> shape correction and stuff like that which have basically just got one project manager, one engineer, like myself, and we do the work together.

Other reasons for the importance of project involvement to engineers' competence are the evolving nature of the profession and aspects of the nature of New Zealand civil engineering. New Zealand engineering has a very general civil engineering degree, a "jack of all trades" culture, and performance-based rather than prescriptive legislation, and these characteristics contribute to the significance of on-the-project-learning. The extent and importance of on-the-project-learning was very strongly emphasised in the present study (see Chapter Five on experience gains and Chapter Six on reflective learning). That is, engineers gain the competence to undertake difficult projects, by doing them.

3.3.4 Practising within competence

Despite the need to gain competence through on-the-project-learning there is a strong norm in the engineering profession that engineers should avoid areas where they do not have appropriate competence. That is, engineers should work within their own competence.

> I despise people that I think don't have competence but won't acknowledge that, and sell themselves as having competence. I think despise is the right word... ...come the end of the day if you are asked for your professional opinion, either you have the ability to give it or you haven't and if you haven't, you'll say, 'no sorry, that's outside my expertise'. I am quite happy doing that. I did it this morning talking to one of the workers. Cos I tend to be a leading hand. So I rang this guy - I said, 'you know what you are b***** doing', I said, 'I wouldn't have a f****** clue'. He said, 'and you're prepared to admit that?', and I said, 'I'll f****** admit anything if I don't b******* know, why shouldn't I? I don't claim to be all knowing and omnipresent, you know'.

> ...obviously I wouldn't want to put my hand up and say I'll design a high rise building.

Associated with the professional norm that you should practice within your competence is a fear of failure or of being seen to be incompetent, which is discussed further in Chapter Eight.

> Oh nobody likes to be an idiot do they? We don't want to do things wrong. I toyed with the idea of doing an MBA but I think it is a waste of time, and certainly a waste of my recreation time, but I read relevant journals, try to learn from the mistakes of other people... ...Oh everybody does (have a fear of failure). Of course. I mean how many people are going to line up and say, 'oh no, I am not frightened of looking like a complete dick head', of course everybody is.

The importance of this norm about practising within one's competence may have arisen as a way of protecting the public from the potential effects of incompetence by engineers. The concern that engineers have for the affects of their work on others forms part of their dual concern, which is another property of the common concern.

3.3.5 Dual concern

How competently engineers perform has potential consequences for themselves, their employers and other people or environments that may be affected by the project. Accordingly engineers have a dual concern: a concern for the self and concern for others.

The consequences of project involvement for engineers are often tightly connected to the implications of their projects' performance for others. For example, engineers can feel that their competence is defined by their clients' satisfaction with, or the public's acceptance of, their projects (as discussed in Chapter Six), so the effects of their projects on these people influence perceptions of the engineers' competence. Often engineers' concern with the self is not explicit, instead it is embedded in the concern for others. The importance of the dual concern is revealed in the process of consequence appraisal (discussed in Chapter Seven), where engineers try to anticipate the consequences of their involvement in the project for the self and others.

3.3.6 Perceptions of competence

Engineers' competence is not only gained, but also demonstrated through project involvement. Thus people's perceptions of engineers' competence are influenced by the performance of those engineers' projects. Engineers are often concerned that other people inappropriately attribute poor project performance to their (in)competence, whereas engineers often think that factors largely outside their control contributed to the poor performance of the project. This concern is deal with further in Chapter Six.

3.4 Conclusions

The present chapter presented a wide range of features of project involvement that contribute to projects being perceived as difficult. While the characteristics of specific projects can contribute to project involvement being difficult, many other

features to do with the relationships between engineers, their projects and their social settings were found to be important to the perceptions of difficulty. The common concern that underlies why these many features are important to project difficulty was then presented.

The common concern is to do with performing competently in the roles that are presented by project involvement. Engineers are concerned with performing competently both for themselves, and for the impacts that their performance may have on others affected by the project. It is through project involvement that engineers gain many of their competencies. It appears, however, that there is a dilemma inherent in the civil engineering profession. On the one hand, engineers both inexperienced and experienced, need to learn on the job, they are expected to have a wide range of experience, and to deal with evolution in the profession. But on the other hand, they are expected to not work outside their own competence. This shows that engineers in their day to day lives are having to balance the need to gain competence through working on projects that challenge their competence, and yet not going too much beyond their current competence. This common concern is further exacerbated by people developing perceptions of engineers' competence based on the performance of their projects, when project performance is affected by many other factors in addition to their competence. I will now introduce the competence frontier, which is the core category that accounts for the variation in behaviour of engineers as they deal with this main concern.

Chapter 4
Core category: the competence frontier

4.1 Introduction

The core category is the category that accounts for the greatest variation in behaviour as the research participants go about processing their main concern (Glaser, 1992, p.77). In this study, the full title of the core category is *the processing of the competence frontier in the context of project involvement.* In brief, the competence frontier can be described as each engineer's self-concept of the approximate position of their competence in terms of fulfilling their roles with their projects. A more complete definition of the concept of the competence frontier is achieved through a description of its properties. The core category is a reflection of the underlying problem in that "the research problem is as much discovered as the process that continues to resolve it, and indeed the resolving process usually indicates the problem. They are integrated" (Glaser, 1992, p.21), and so the properties of the core category reflect the features of the underlying common concern (discussed in Chapter Three). The properties of the competence frontier are that it forms part of an engineer's *self-concept* and also contributes to their *self-esteem*, and that engineers are concerned with *performed situational competence, frontier advancement, borderline competence, competence uncertainty* and *influencing outcomes*. There are three interactive processes involved in engineers processing their competence frontiers in the context of project involvement. These are referred to as categories of the competence frontier and they are introduced in Section 4.9, and form the subjects of Chapters Five to Seven.

The term "the competence frontier" is not an in vivo code. This code emerged from the earlier name for the core category, "being competent", and the code "experience frontiers" which Barney Glaser had noted on a memo that I had sent him. The term "the competence frontier" has different connotations to similar terms that could have been used to describe the core category. These connotations stem mainly from the imagery that we associate with the word "frontier". The term frontier is traditionally associated with the frontline or foremost part of an army, that part of a country that

forms the border of its settled or inhabited regions, the part of a country that borders another country, or the outer limit of a field of knowledge (Flexner, 1987; Simpson and Weiner, 1989). The properties of concern with performed situational competence, borderline competence and frontier advancement fit with the imagery of the word frontier.

Discussion of the properties of the competence frontier follows.

4.2 A part of the self-concept

The competence frontier is part of an engineer's self-concept. The self-concept is an accumulation of a set of beliefs about the self. It refers to how one views oneself, as differentiated from how one is known to others, the reality of oneself in terms of behaviours and traits, or the person that one would like to be (Baumeister and Tice, 1986). That is, the competence frontier is an engineer's view of his or her competency in fulfilling his or her role in engineering projects. The competence frontier is not a fixed standard of competence through which engineers hope to pass at some point in their career. It is rather an ongoing self-image that each engineer develops and refines on an event-by-event or continuous basis. The following quote provides an example of an engineer developing a belief about the nature of his competence through project involvement.

> I guess it's something that comes with experience and as you tackle harder and harder projects and do well at them you realise that you have a knack for it. So they are the ones you actively seek out more and more.

Knowledge about the self is stored in a very loose fashion and so it is appropriate to view the self-concept as an aggregate of self-schemas (Baumeister, 1998, p.687). Other self-schemas that make up engineers' self-concepts may include beliefs about the self such as ability as a parent, spouse, sports-person and so on. That is, the competence frontier forms only a part of an engineer's self-concept. The importance of the competence frontier to the self-concept is evident in the motivation of engineers to enhance their competence, which is discussed in section 4.5.

There are two theoretical terms used in the literature to describe self-concepts of competence; these are "sense of competence" and "perceived (self-)competence".

The sense of competence is the subjective feelings that individuals have about their abilities and reflects their confidence resulting from their cumulative interaction with their environment (Wagner and Morse, 1975, p.451). Perceived self-competence is "an individual's subjective evaluation of task-related ability, a self-appraisal of what one can do in a specific situation" (Williams and Lillibridge, 1992, p.156). In essence the two concepts are equivalent, however the sense of competence is more global, while perceived competence is task specific. Both task specific and the more global sense of competence are important to engineers, that is, they are concerned with their ability to be competent with a wide range of situations. Thus both the sense of competence and perceived self-competence are important to the competence frontier.

We tend to think of competence and incompetence as characteristics of an individual, however, these are labeling phenomena that are influenced by the societal concepts of competence (Langer and Park, 1990; Sternberg, 1990). For example different cultures, socio-economic groups, occupational groups, and age groups have different notions of intelligence (Sternberg, 1990). While engineers' competence frontiers are their own perspectives of their competence, this view tends to be significantly influenced by how other people view their competence. Other people's views are also important to the background expectations against which the competence frontier is set. These background expectations involve the level of competence desired in the engineer's performance, both by the engineer, and by others.

Background expectations that engineers take on as their own expectations are self-guides. The self can be conceptualised as incorporating the actual-self, the ideal-self and the ought-self. Each of these self-states can be held by the individual or by others, so there are six self state representations: actual/own, actual/other, ideal/own, ideal/other, ought/own and ought/other (Higgins, Klein, and Strauman, 1987). The latter four self-states form our self-guides that we use for comparing to our actual states in the process of self-evaluation. The position of the competence frontier is assessed relative to self-guides, which can develop and change through project

involvement. That is, engineers develop concepts of how competent they ought to be, or ideally should be, in addition to how competent they think they actually are.

Many engineers are concerned not only with their own personal competence, but also the competence of their employer, and the people who work for that employer or even the profession. This indicates that the competence frontier can be embodied not only in an engineer's self-identity, but also in the identity of the engineer's employer and profession. In the following quote, for example, an engineer who has a fairly senior management position is concerned about perceptions of the competence of engineers within his company.

> You don't like to, I guess, own up to the incompetence of people that were involved in the project because it reflects badly on your company, 'how could you have allowed that to happen?' And you personally even though all this occurred before you arrived on the scene, it is your company, you are assuming responsibility for that, and yeah, it is emotionally very draining and very difficult...

The concern of engineers for the competence frontier of the profession is evident in the discrepancy between their view of the profession's competence and the views of the general public. That is, engineers desire the public's view of the engineering profession's competence to be improved.

> One of my pet things there (on a committee) was to raise the identity of the profession in the community. Because I think we (engineers) have sat in the backrooms doing the sums for too long. And when you think about life as we know it, everyone comes into contact with engineering everyday, and I'd like to see that reflected more in engineers' profile.

Although competence frontiers can be viewed as a part of companies or the profession, the focus in the present study is on the competence frontiers of individual engineers. The property that engineers' competence frontiers form a part of their self-esteem will now be discussed.

4.3 A part of self-esteem or self-worth

The proposition that engineers' competence frontiers form a part of their self-esteem is supported by their descriptions of their confidence and/or self esteem being affected by how well their projects are going, which can reflect on their competence.

> I think if you have got a project, which is running well, you get quite a buzz from it... ...and by I guess reflection you know darn well that other people may look after you because of it. Yeah... ...A difficult project I think you

> can often feel that perhaps you are not competent to run it... ... and you do lose self esteem in those sort of situations.

That engineers' perceptions of their competence are important to their self-esteem is supported by the theory on perceptions of competence and self-esteem. The terms "perceived competence" and "self-esteem" or "self-worth", are often used interchangeably, however they represent different phenomena, with perceived competence being the judgment of personal capabilities, while self-esteem or self-worth is the degree to which one likes or dislikes oneself (Bandura, 1990, p.329). If, however, the perceived competence is measured in a capability considered important to oneself then inflated correlations between perceived competence and self-esteem are likely (Bandura, 1990, p.329). In other words self-esteem is developed through perceiving competence in areas that one considers important to oneself. Indeed, Wagner and Morse (1975) argue that the importance of the concept of "sense of competence" (referred to in section 4.2 above) is because self-esteem is contingent on a sense of competence. Consistent with this argument that the sense of competence is important to self-esteem, Tharenou and Harker (1982) describe self-esteem as having two parts: global self-esteem and sense of competence (p.798). They found that the sense of competence was a more useful variable than global self-esteem for assessing work-related outcomes. The importance of being competent at work is also evident in a study that found that job competence is one of twelve dimensions of self worth in adults that contribute to the adult's global self-worth (Harter, 1990). These dimensions include for example, intelligence, physical appearance, sociability, morality, household management and adequacy as a provider (Harter, 1990). We can conclude that the competence frontier forms part of an engineer's sense of competence or perceived self-competence, which then contributes to their self-esteem.

While the above authors argue that the sense of competence is a component of self-esteem, Moretti and Higgins (1990) argue that self-esteem is related not to the actual-self attributes, but to self-discrepancy, which is the difference between the actual-self and the self-guides (p.290). For example, a large discrepancy between the actual-self and the ideal self-guide is associated with low self-esteem (Moretti and Higgins, 1990, p.290). That is, the position of the competence frontier is held relative to a

background of self-guides, and it is the relative position that influences self-esteem. Harter (1990) found that public sources of support, such as co-workers, are a critical avenue for feelings of self-worth (p.86). This is likely to be because of the role of co-workers in influencing the individual's self-guides and perceptions of his or her actual performance. For example, in the following quote from the present study an engineer describes her confidence being affected by the comparison other people, including colleagues, make between her actual performance and the performance they think she ought to achieve.

> I think, actually it is quite interesting because a lot of that - oh I don't know, for me personally anyway - a lot of the confidence I get is dependent on other people's reactions. So if I feel if the client is happy with what I am doing and he is happy with the price and we are achieving it within the programme that was set, then I feel quite confident about the project and about my performance. And the same thing internally as well. If I feel that other people in the office think that I am in control of a project and approve of the way that I am going about it, that really affects my confidence too.

In summary, the competence frontier is important to engineers' self-esteem or self worth, and it is the relative position of their competence frontiers to self-guides that influences the level of confidence that they feel. Actual performance and self-guides can change from project to project and during a project, so engineers are concerned with being competent in the changing situations they face. Concern with performed situational competence is the code that describes this concern and is discussed next.

4.4 Performed situational competence

In circumstances we associate with frontiers, people are faced with a wide range of challenging situations, and it is important that they cope with those situations, or else some form of retreat usually occurs. The concern of engineers is not with competence as an inherent characteristic, but with performed situational competence, that is, competence as performed in the different situations in which project involvement places them, as introduced in Chapter Three. An example of the importance of performed situational competence is that it is the ability to get projects through milestones and actually implemented which is considered important.

> The worst engineer is the one who is always perfecting designs, whereas in the real world you build something. I quite like design myself, but it's only a mathematical problem, that's all it is. The real objective of engineering is to build things, not to solve puzzles. The design is an important part of it but Uni graduates come out thinking it's the only part of it.

The nature of situations faced by engineers mean that they need many different types of competencies, which are important to their competence frontiers. This means that engineers' competence frontiers are multi-faceted. The competencies raised as important by participants in the present study are discussed in Chapter Five. The following quotes are presented here to emphasise that there is more than technical engineering expertise necessary in the work of engineers.

> And really I guess it's just a huge balancing act at the end of the day. A lot of financial control, pitted against logistical work in terms of running the program, pitted against technical things, which is building the job to the quality standards you need to and client satisfaction... ...I learnt a lot in terms of logistics support, getting client satisfaction. The more conceptual realm of engineering, the bits we don't get taught at varsity.

> You have to constantly keep in mind that a solution is no good if it is an engineering solution that they can't afford at the end of the day. So you are constantly charting economic things as you are going through, social things, environmental things, legal things. So you want a product that is going to run, solve a problem that you have got, or at least put things into reality.

> ...if you keep explaining things as fairly and as calmly as you can, and not lose your cool yourself... ...You can normally win the situation if you do remain calm and so I guess it is a survival strategy. If you allow your emotions to start racing away and getting angry, (but I am not a person that normally gets angry, I can get annoyed with some things), but no you have got to control that and just keep answering logically. Getting into a slanging match, everything just goes out the window then.

The facets of competence frontiers tend to change in importance and relevance to engineers as they advance through their careers moving from project to project and to different levels of responsibility, with associated changes in expectations of their competence. Engineers' concepts of what facets of competence are important develop and become wider as they experience being involved with projects, learning what works and what does not work, and also what is important to other people. For example, engineers often shift from an interest and emphasis on technical competence to an interest in more managerial types of competence.

> As you develop professionally the philosophy changes. I think early on in my career I was more interested in the technical aspects of the job. I think increasingly now I get much more of a buzz from some of the relationship things: relationships with staff, with clients. Satisfaction from presenting a job that was well done, and getting repeat business from a client because they come to you because they trust you and know that you will deliver.

The resources an engineer can use, and the influence of external factors on project performance, can be important to the engineer's performed situational competence. Thus performed situational competence is dependent not only on the inherent abilities

of the engineer alone. This accounts for the importance of factors such as the support situation and the project set-up to the perceived difficulty of projects.

As a result of the wide and changing range of competencies required by engineers they often gain in competence, that is, their frontiers advance. The property of frontier advancement is now discussed.

4.5 Frontier advancement

We often associate frontiers with the desire of people to advance them. In discussing the underlying common concern, in Chapter Three, I described the strong motivation that engineers have for enhancing their competence, and this indicates the importance of frontier advancement. The motives for frontier advancement can be categorised as intrinsic or engineering identity rewards, and extrinsic or role expectations. Motives can also be viewed as a desire to move away from something feared and towards something desired.

Maslow (1954) developed a 'hierarchy of needs' model, going from basic physiological needs, to safety needs, love needs, esteem needs and finally the need for self-actualisation, which is the desire to reach one's ultimate potential (Watson, 1995, p. 47). Related to these higher and lower level needs was Herzberg's (1966) two-factor theory of work motivation incorporating 'hygiene' factors such as salary and working conditions, and 'motivation' factors such as achievement, recognition, growth and responsibility (Watson, 1995, p.48). Later, 'hygiene' factors became associated with the concept of 'extrinsic motivation', that is external forces that control behaviour, while 'motivation' factors became associated with 'intrinsic motivation', where individuals provide rewards to themselves (Landy, 1985, p.369-370). While there has been some debate on the distinction between, and the effects of extrinsic and intrinsic motivation, see (Landy, 1985, p.370), these concepts are nevertheless useful in recognising that factors both external and internal to engineers are important to their motivation to enhance their competence. For example in the following quote the engineer discusses both intrinsic (learning and gaining future

challenging work) rewards and extrinsic (financial) rewards as important to his motivation to enhance his competence.

> I enjoy learning and that is part of enhancing your competence, so I have personal satisfaction in enhancing my competence, also financial rewards associated with enhancing your competence, it's also about having more challenging work...

Intrinsic motives to advance the frontier can be associated with the engineer's *engineering or role identity*, while extrinsic motives are associated with *role expectations*.

4.5.1 Engineering or role identity

Carver (1996) states that people have abstract, high-level goals that they pursue by means of lower-level activities (p.646). So it is through the performance of tasks that people hold onto their self-esteem, to their general sense of fit between their present self and their desired or ideal self. A high level goal for engineers is their desire for the engineering or role identity, that is, the desire to be a competent engineer, or to be competent in their employment role. For some engineers the concept of being an engineer is particularly important to their identity. Indeed, a strong engineering identity was found to be a significant value in the culture of engineering education in a New Zealand university (Godfrey and Parker, 1998b). The following quotes from the present study illustrate this importance of engineering to engineers.

> I think (being an engineer) is a fair bit of my identity... ...So I regard myself as an 'Engineering Manager'... ...'to be manager of a large engineering concern'. I would get little satisfaction out of selling shoes or Coca Cola, even for a lot more money than managing (an asset).

> Now engineers have a great deal of difficulty in having to deal with other professionals because they have been brought up with the view that theirs is the prime discipline. That it is important and that people like planners and property consultants etcetera are only peripheral to the real engineering that has got to be done on this project.

For other engineers the concept of engineering is closely associated with the concept of design, and they consider their role to be more managerial or planning in orientation. These individuals want to be competent in their job role. So the desire of engineers to succeed with a project is nested in their high-level goal to be a successful engineer, or successful in their job role. To be a competent engineer involves a continuing advancement in the frontier in order to remain competent. Some engineers may appear to have a low motive to enhance their competence, however all

participants in this study, indicated an interest in enhancing their competence. The engineering or role identity motive is a fairly stable motive that continues to drive engineers to attempt to advance their competence throughout their career, and for some, into retirement.

> There were a couple of guys in retirement (who were still trying to enhance their competence). I mean they were always going to courses and giving some lectures as well and (were) also keen to pass on their knowledge to the younger guys. So they are definitely, the ones that I worked with anyway were definitely keen to keep that going.

> I think the interest and the desire (to be a better engineer) is as strong now as it was.

Performing competently in their work is important to engineers because they believe that the more competent they are the more interesting the projects they will become involved in. There are engineering jobs that can become mundane and boring and this is something that engineers wish to avoid. In the following quotes the engineers express strong intrinsic motivation which they associate with interesting work.

> I saw a quote this week 'I'd rather die of thirst than drink from the cup of mediocrity'. I like that. I like difficult and challenging projects because they are always the most interesting. I've never tried to shirk that: and if you did you would become extremely bored and maybe bitter about that.

> I would be a bit disappointed within myself, looking forward, if I didn't continue to make some efforts to try and do things better. It is almost like a little bit of a zest for learning I think, to try and find new things and understand them.

> I really take pride in what I am doing. I imagine I could have done medicine and I would be as enthusiastic about medicine as what I do now. I think most professionals take a professional degree of pride in what they do and it has to be reasonably interesting for them to do it, intellectually and emotionally.

Part of the intrinsic motivation of the engineering identity is the associated ability to influence tangible outcomes that are perceived to be of benefit to the community (see also the importance of influencing outcomes in section 4.8). For example, involvement in large durable projects is of considerable satisfaction to civil engineers. Indeed, engineers can continue to obtain considerable satisfaction from being involved in projects long after their involvement ceased, because of the durability and visibility of these projects. This desire for tangible control is a very strong motive for some engineers.

> I do enjoy influencing people, and often it's the (client) who I'm trying to influence. I also try to influence my staff, so they enjoy the job...

> ...'Footprints in the sand': building something that's an achievement, it will still be around long after I'm dead... ...In (my) work you do get to help people. It really feels good to think that we will be helping people, making their lives better. There're not a lot of jobs where you get to do that.

> One thing that I can say is that because the work is local, it is built and implemented, it is sometimes just a good feeling to see what it looks like in three dimensions, 'it looks great eh!' When you see people using it in the way you intended it to work it certainly is a good feeling.

Intrinsic motivation associated with being competent as an engineer can also stem from the rewards of gaining a sense of affiliation with others. The importance of affiliation rewards is evident in the emphasis that engineers place on the development of relations as a result of working on difficult projects, which is discussed in detail in Chapter Five. The concern of engineers with how their co-workers view them also indicates this need for affiliation.

> I've always taken pride in the fact that in twelve years working for (my employer) I've never lost any key staff, and I guess that's due to personal loyalty: a good team spirit in my area, and they like working for me - that's their loyalty to me and their affiliation to the team more than loyalty to the (employer).

Even if engineers want to gain the intrinsic rewards of enhancing competence through project involvement they may not be able to, in part because projects are often challenging due to unforeseen problems arising.

> (Difficult projects are important to engineers career development), if you can get them, because it challenges you. But there is not the chance to get onto those sort of projects at the beginning because a lot of the time they are not known to be difficult. The difficulty arises as you get into it. From the standpoint of broadening your experience, yes they are very important. But the chances of getting one is the luck of the draw.

Thus the intrinsic rewards associated with meaningful and interesting work that involve enhancing competence often arise from attempting to fulfil one's job role. It is the expectations of their job role or project role that form the dominant extrinsic motivation for engineers.

4.5.2 Role expectations

Role expectations are expectations of performance that are placed on an engineer by others, hence the expectations are extrinsic motivators.

> You are put into a position to manage and, by God, you get in there and you are expected to manage.

Features of the context of civil engineering in New Zealand influence the frequency and extent to which the role expectations require engineers to work with low experience relevancy or borderline competence, thus necessitating improvement in their competence. Civil engineering is an evolving profession and this often contributes to engineers working with borderline competence.

> (I am motivated to enhance my competence as an engineer because) the engineering in my particular branch that I am technically competent in, there are always new challenges and disasters that go wrong that test the limits of your state of the art, I guess, of solutions.

The introduction of the Resource Management Act 1991, and the Building Act 1991 in New Zealand, for example, have contributed to the need for engineers to develop their competence. Similarly, many aspects of fire engineering and environmental engineering have developed significantly in New Zealand in the last decade, demanding enhancement in engineers' competence. These sort of influences can result in particularly challenging projects as not only are the engineers' experience relevancy low, but so is the experience relevancy of many of the other people involved in such projects.

Ongoing research continues to contribute to knowledge relevant to engineering and this contributes to the evolution of the profession. New materials, the expanding use of computers and their associated software packages, new construction methods, and different contractual processes are all encountered by many engineers during their careers, placing them in positions of low experience relevancy.

New problems or approaches to solving problems also occur with surprising frequency. For such cases there may not be any appropriate legislation, or readily transferable knowledge. New Zealand is a small country and a low level of resources is usually applied to investigating and solving problems in comparison to the work done in many other countries and these constraints can result in very challenging work.

In situations where role expectations require engineers to gain in competence they can have an associated fear of failure, which motivates them to enhance their competence.

4.5.3 Fear of failure... ...desire for success

Carver (1996) argues that all goals involve motives to move away from an undesired condition and towards a desired condition and that the behaviour at any moment depends on the motive which is strongest at that time. Thus in attempting to gain, maintain and demonstrate competence engineers are attempting to move away from failure and towards success. Some engineers are more strongly motivated by the fear of failure, while others appear more strongly motivated by the desire for success. The fear of failure or being seen to be incompetent was admitted to be, or to have been, an issue for many engineers I interviewed, and this is discussed further in Chapter Eight.

In summary, engineers are motivated to advance their competence frontiers because of the intrinsic motivation of high level goals to be successful engineers or successful in their job roles, or the extrinsic motivations placed on them through the role expectations of their work. Associated with these motivations can be a fear of failure and a desire for success. These reasons for frontier advancement are why engineers often work with borderline competence, which is important to the common concern of engineers' regarding difficult projects and is discussed next.

4.6 Borderline competence

The concept of a border is important to definitions of "frontier". The border in the competence frontier is the outer limits of an engineer's competence. It is in situations where engineers have low experience relevancy that they are likely to be working at the outer limits of their competence. This does not mean that they are likely to be incompetent, but it does mean that they have to gain and demonstrate competence on the project, that is they are working in areas where they do not have confirmed competence.

> I was very much dumped in the deep end on that one (as Project Manager). I had never really run a construction project by myself. There was support on demand but not in terms of a boss sitting beside you each day. The manager of part of the company rang up and said, 'do you want to run this for us?'. I said, 'yeah' (sounds tentative). I was given a set of documents, introduced to the client and told, 'go to it'. I had never put together a crew on a construction site or anything like that.

Frontier advancement occurs through project involvement by engineers working with borderline competence. I have argued that the context of New Zealand civil

engineering contributes to the extent to which role expectations require frontier advancement, and this also indicates the frequency with which engineers are working with borderline competence. In addition there is a culture in New Zealand of throwing engineers "in the deep end". For example, the ability to work hard under pressure and to be challenged to stretch one's limits was a part of the culture of engineering education in a New Zealand university (Godfrey and Parker, 1998a). The following quote from my study also indicates this culture.

> I also try to influence my staff, so they enjoy the job. I don't enjoy trying to control their day-to-day roles. I've never enjoyed people doing that to me and have always made a conscious effort not to do it. I've given them freedom so they can achieve, or give themselves enough rope to hang themselves with. If you let people try to perform as well as they can then they generally do.

As engineers move into positions with more responsibility they can become involved in interfacing different disciplines of engineering and this can contribute to them being involved in fields in which they are working with borderline competence.

> Projects which involve a broad range of technical disciplines (can be quite unpredictable), like plant, not necessarily bridges or the development of civil engineering structural things, but things which may involve mechanical plant, electrical systems, environmental and water treatment systems where they have got electrical or mechanical things. And then you end up being in the position of - there is a whole lot of stuff that you just don't know - you might end up in a position of being responsible for the making of a decision which is wrong but because it is in somebody else's discipline that - you can think, 'oh damn them all the way around'. You can take control of the project, and you could make yourself a disaster.

Working with borderline competence increases engineers' perceived risk of being seen as incompetent and hence their fear of failure and job stress. The professional norm that engineers should work within their competence is also likely to increase their fear of failure. In the following quote the engineer associates borderline competence with uncertainty and the feeling of dread.

> Hopefully the feeling of being dropped in the deep end lessens and it becomes exciting and then it becomes routine, and then you go and do another job. That is the ideal wish, it is not necessarily the case, often the feeling of dread increases... ..You are seriously out of your depth and there isn't help, or you feel that you are working at the edge of your ability, whether that be technical or otherwise and that you may well be organising a disaster for yourself somewhere further down the track, or that other people might be organising a disaster for you and paving the way with time bombs which are duly going to explode. It depends on how on top of it we feel.

4.7 Competence uncertainty

The frequency of competence uncertainty in civil engineering is in part due to the frequency with which engineers are working with borderline competence. While engineers may normally be confident of their competence, moving into a new area of engineering can increase feelings of competence uncertainty.

> Some time ago when I moved into (another type of engineering that was not my area of expertise). I had done a bit supporting another director on some projects, so I had some prior experience, but it was an area that wasn't really under my fingernails... ... so yeah I have felt being in the deep end on some of those projects.

Try imagining yourself as part of a physically located frontier, either a military or explorative frontier. If you do not have a map, or if you have a map but you did not know whereabouts on the map you are it could be hard for you to conceptualise the location of the frontier. Similarly, engineers can be unsure of the position of their competence frontiers. It is the situations presented during involvement in difficult projects that are likely to make engineers feel uncertain about their competence. There appear to be three types of competence uncertainty. Firstly, engineers can be uncertain about the standards of competence that should apply to their work: they don't have a map. Secondly, they can be concerned about whether they are meeting, or have met appropriate standards or expectations in their work: they don't know whereabouts they are on the map. Thirdly, engineers working with borderline competence tend to be uncertain about whether or not they will be competent enough to meet the challenges presented by the project. They may not know what challenges they will meet, that is, they don't know how to read the map, or whether they can cope with those challenges.

The first type of uncertainty: uncertainty with regard to what competence is actually desirable for the project, occurs predominantly in areas where there is a lack of clear-cut prescriptive standards and procedures that show what is competence and what is incompetence. This uncertainty about standards or procedures occurs particularly when both the engineer and relevant others lack experience relevancy, which applies to the situation of the following quote.

> We had major strategy discussions where we went basically in circular arguments for five days. Trying to get to a point where we could say, 'based upon this, this and this we can actually make a decision'.

This type of uncertainty can extend to uncertainty over what the professional standards of practice should be for the type of problem presented by the project. For example, many engineering structures are designed for rare events such as earthquakes, floods or fires. This means that many aspects of the state of the art of design are rarely tested. This is reflected in the uncertainty of the competence of the profession expressed by code writer, Andy Buchanan, and Principal and Director of Earthquake Engineering, Beca Carter Hollings and Ferner Ltd, Richard Sharpe, in the following quotes.

> How do we know, as designers or code writers, if we have got the right level of safety? For earthquake design we have to wait for a major event, and that may take many years. For fire design there may be no collective major event, because most fires occur one by one. We have to investigate each fire and collect data until we see a pattern of safety emerging. We may wait a long time before we know if we are in the right ballpark... ...What will be the reputation of professional engineers after the "big one"? How many lives and how many millions of dollars are resting on our shoulders? (Buchanan, 1999, p.5).

> ...our knowledge of the effects of earthquakes on structures and our skills in seismic design have increased dramatically. Whether we have implemented that knowledge sufficiently is less certain... ...It is much less clear as to whether we are sufficiently prepared as the public will expect for the aftermath of a severe earthquake affecting a major city.... ...Will we as earthquake engineers be found wanting by the public when the day of judgement of our structures comes? (Sharpe, 1998, p.32-33)

The second type of competence uncertainty - the concern with whether one is meeting expectations of competence - is contributed to by the lack of explicit feedback received by engineers about their competence. Engineers therefore attempt to assess their competence by assessing the performance of their projects. However, there is often uncertainty about the correlation between an engineer's competence and the performance of the project. The present study identified that there were both cognitive and social processes involved in engineers assessing their competence, and these processes are discussed in Chapter Six. This type of competence uncertainty is also likely to occur in situations where the first type of competence uncertainty applies: if you don't have a map (such as having no applicable engineering codes) you cannot work out where you are on it!

The third type of competence uncertainty involves an anticipatory cognitive process where engineers attempt to identify whether they will be sufficiently competent for the project. This process is described as *consequence appraisal* in Chapter Seven. In addition, this type of competence uncertainty is reflected in engineers' fear of failure, which is discussed in Chapter Eight.

In conclusion, competence uncertainty involves cognitive uncertainty about one's own competence and this may be reflected in feelings of anxiety or fear of failure. Competence uncertainty frequently arises out of involvement in difficult projects, and the feelings associated with competence uncertainty become significant motivators in the processes associated with the competence frontier.

I have now discussed six properties of the competence frontier: that the competence frontier forms part of an engineer's *self-concept* and also *self-esteem*, and that engineers are concerned with *performed situational competence, frontier advancement, borderline competence* and *competence uncertainty.* The importance of these properties of the competence frontier, and indeed why engineers' competence frontiers matter at all, can be summarised by their ability to influence outcomes.

4.8 Influencing outcomes

One only needs to read the books by Laura Ingalls Wilder about pioneering days in America to see that people choose to be part of a frontier because they believe there is something to be gained from that participation. Similarly, engineers choose to be involved in difficult projects, and think about and attempt to advance their competence, because there are gains to be made from doing so. These gains include engineers' intrinsic and extrinsic rewards that are associated with improving their competence as discussed in section 4.5 on frontier advancement. Here, however, I wish to emphasise a broader perspective on the gains that are made by engineers having existing competence and advancing their competence frontiers. This is described by the term 'influencing outcomes'.

Recall in Chapter Three, that engineers have a dual concern, that is, concern for the self and concern for others affected by the engineer's involvement in the project. This translates into engineers' attempting to influence outcomes for both the self and others.

> I think I probably get a little emotionally involved in the project that you are doing and you really want to do a good job for whoever, make sure the environment is protected or make sure that health is protected, and see the right outcome.

It is through the gaining of competence that engineers are enabled to effectively influence outcomes. We need engineers to continually advance their competence so that they can meet the challenges of the projects that society requires of them. And we need them to be involved in the difficult projects that the development and maintenance of civil infrastructure requires. Fortunately engineers are interested in not only gaining competence, but also using their competence for the benefit of society.

> I want to work for the better of society really... ...I am really keen to improve conditions for (the public). If I am not motivated to learn new things then I won't get there.

> ... it's the resource consent hurdle that's the big thing nowadays. Once you have hit that, then you can almost, now in my role, move onto the next one. Except you don't want people to go b***** crazy and blow your budgets and you want to get a thing that, you know, (does) whatever it's meant to do.

Thus we can perceive the concern of engineers with their competence frontiers as something that involves not only self-interest, but also the wider benefits to other people. Perhaps a reflection of this is that other people are often concerned about engineers' competence. So engineers' concern with their own competence is nested in their concern about what other people think of their competence. Accordingly social processes occur in the three interactive processes that are involved in the processing of engineers' competence frontiers.

4.9 Conclusions

In this chapter the competence frontier has been introduced as the core category which accounts for how engineers go about processing their common concern with difficult projects. The competence frontier was described as part of each engineer's self-concept and a part of their self-esteem: it is engineers' perspectives of their own

Figure 4.1 Summary of the three processes of the competence frontier

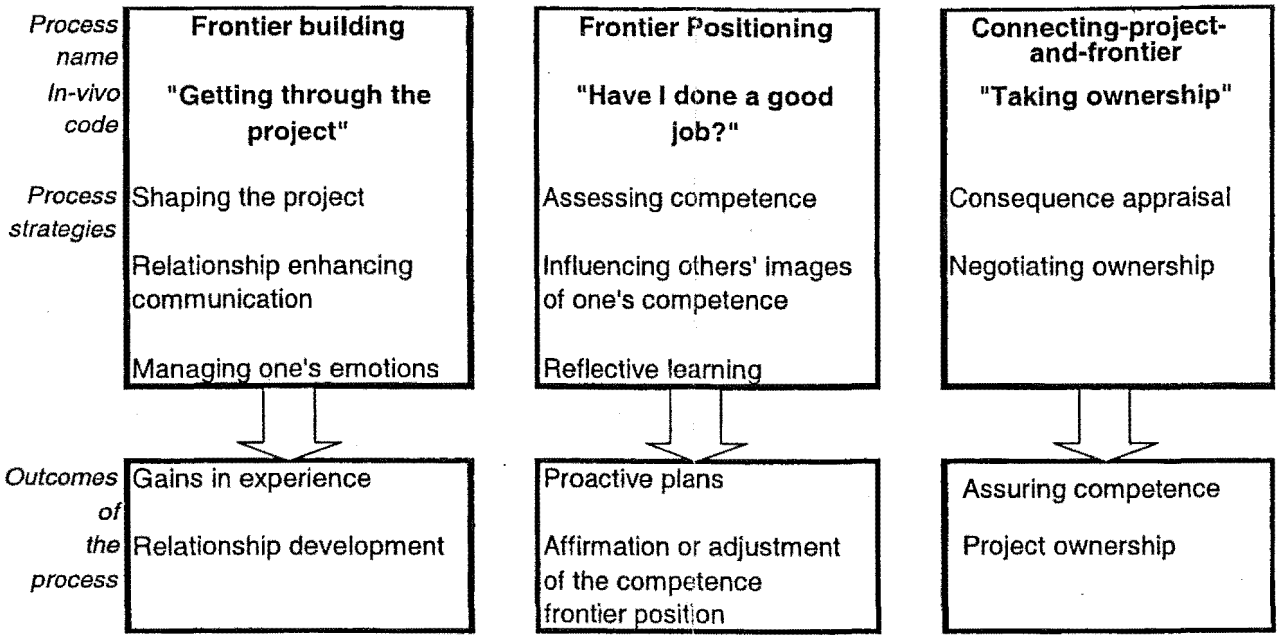
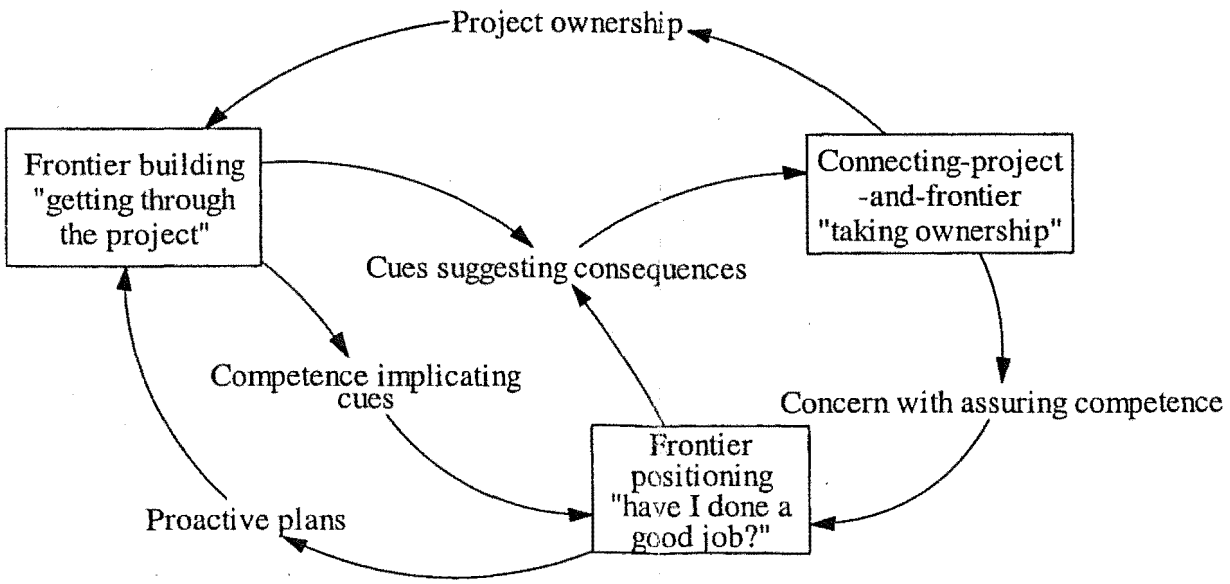


Figure 4.2 Links between the three processes



competence in fulfilling their roles with their projects. In the context of involvement with difficult projects the focuses of engineers' concern with their competence frontiers were described as concern with performed situational competence, frontier advancement, borderline competence and competence uncertainty. The importance of the concern with competence is because of the ability of engineers to influence the outcomes of projects.

In the following chapters the processes by which engineers manage their competence frontiers in the context of difficult projects will be explained. There are three concurrent, interrelated processes, each discussed by one of the following three chapters. To aid readers' comprehension of how these processes are important to the grounded theory they are introduced here.

The three processes are *frontier building*, *frontier positioning* and *connecting-project-and-self.* Together these three categories account for how engineers go about resolving their concerns about their competence frontiers in the context of project involvement. Figures 4.1 and 4.2 (page 96a), outline these processes and their interrelationships, and may be folded out to view while reading the text in the following chapters.

Frontier building is the process whereby engineers go about advancing their competence frontiers through project involvement. Frontier building is indicated by the in vivo code *"Getting through the project"*.

Frontier positioning is a process of gaining self-knowledge, which involves engineers establishing or reaffirming their self-concepts of the approximate position of facets of their competence frontiers. Frontier positioning is indicated by the in vivo code "*Have I done a good job*?"

Connecting-project-and-frontier involves engineers having a sense of the self as being significantly involved in the project. That is, that the project is significant to the engineer's competence frontier, and the engineer's competence significant to the

project. Connecting-project-and-frontier is indicated by the in vivo code *"Taking ownership"*.

While Figure 4.2 shows the main interrelationships between the three processes, the emotion engineers experienced as a result of project involvement emerged as important additional links between the processes. These links are modeled in Figure 8.1, (page 201a), and are discussed in detail in Chapter Eight.

The extent of interconnection means that all three processes of managing the competence frontier: "getting through the project", assessing "have I done a good job?" and "taking ownership", and engineers' emotional involvement with their projects are important to coping with difficult projects.

Chapter 5
Frontier building: "getting through the project"

5.1 Introduction

The core category, 'the competence frontier', was introduced in the previous chapter. Properties of the competence frontier were described including the concern of engineers for performed situational competence, borderline competence and frontier advancement. The present chapter describes the category *frontier building*, one of the three categories that explain how the competence frontier is processed.

Frontier building is the process of engineers enacting their competence frontiers by undertaking their roles with their projects. It involves the basic activities upon which their competence is established. That is, it is the process of them performing situational competence. As discussed in Chapter Four, engineers are frequently working with borderline competence. This results in experience gains by engineers, so their competence frontiers advance. Frontier building, therefore, is the process of engineers building up the skills, attitudes and knowledge necessary to advance their competence frontiers.

In the previous chapter the competence frontier was described as multifaceted. That is, there are many types of competence that may be relevant to an engineer during involvement with a particular project. Rather than describing all types of competence, and how engineers gain these competencies, the present study focuses on those competencies that have arisen from the data as important to getting through difficult projects. These competencies are presented as conceptualisations of what civil engineers do. In some cases the importance of these competencies to the competence frontier are discussed. Considerable research effort could be expended to identify all of the techniques that engineers use in getting through projects. This is not considered appropriate in this study, however, as it would detract from the central thesis about the competence frontier. Discussion of specific techniques is therefore limited.

Important to engineers' role is their influence on *shaping the project.* Shaping the project occurs more easily if they put effort into *relationship enhancing communication.* Engineers' emotional involvement in their projects contributes to interconnections between the frontier building, frontier positioning and connecting-project-and-frontier processes, as described in detail in Chapter Eight. Difficult projects often involve engineers having to exercise control over their emotions, that is, *managing one's emotions.* Engineers frequently mention *experience gains* and *relationship development* as a result of getting through a project. These are the properties of frontier building that have emerged as relevant to difficult projects.

5.2 Shaping the project

Shaping the project involves engineers attempting to influence the development of their projects. Such attempts may involve them simply trying to do a good job, that is, ensuring that the project is satisfactory from their own perspectives. Shaping the project can involve considerable proactive effort on the part of engineers, especially when projects are not developing in the way they think they should. In the following quote, for example, consultant engineers are proactive in writing to a peer reviewer about resolving communication problems that have arisen with the project.

> However, we wish to discuss some matters now which are of concern to us in terms of potential difficulties or misunderstandings. We wish to resolve them in terms of effect on existing work and avoiding any repeat situations in future. Opuha 1

The term "shaping the project" arose from recognition of parallels between the concept of people acting as agents shaping "passages", for example nurses and doctors influencing the passage of a person going through the dying process, and engineers influencing their projects. The concept of shaping passages is one of the properties of a status passage (Glaser and Strauss, 1971).

Shaping the project is very similar to the conceptual category of "preserving", developed in a study of women engineers by Joyce Fletcher. Preserving involves "activities intended to preserve the life and well-being of the project by taking on tasks that would protect it from harm or prevent future problems" (Fletcher, 1999, p.49). Shaping the project can incorporate preserving the project, but the emphasis is

on engineers' influence on, or potential to influence their projects rather than just activities intended to preserve their projects.

Engineers may be involved in *shaping the content* and/or *shaping the process* of their projects. That is, the shape of a project includes both the content such as the design of the physical system, and the process such as the planned time-frame and procedures to be used. Shaping the process, therefore, involves influencing how and when a project is developed, while shaping the content involves influencing what is done. The following quotes are examples of engineers influencing the content of their projects.

> I decided that the best way to provide the background that she wanted was to use precast concrete.
>
> The client had no idea what to do - so it was a very simple brief. They had already done a design: they thought they just needed to put in (an additional system) and come up with a concept to operate the (system). I had to tell them 'well there are a few specific requirements, you can't just build it like that then (add the system)'. (The interviewee discusses the problems with the client's design and shows the solution he suggested). (Interview notes).

An engineer may contribute to the process of the project by influencing the project's contracts, quality assurance procedures or by managing other people who are involved in the project. Peer reviewers involved in the Opuha Dam project put considerable (unsuccessful) effort in attempting to get an appropriately experienced engineer employed on site. This is illustrated in the following quote from a peer reviewer's letter to the client's representative.

> The Contractor's senior on-site staff appear to have no relevant prior experience in the construction of what is a "high hazard" dam. The lack of experience is directly in conflict with the minimum procedures recommended in NZSOLD's Dam Safety Guidelines... ...I believe that the present on-site staff should be strengthened by the addition of an engineer with a sound background of experience in the construction of high hazard dams. Such a person would be of most value to the project prior to, and during, initial dam construction, particularly where dam construction abuts foundation and hydraulic structure surfaces. Oupha2.

The difficulty with projects is that they can go *out-of-shape*. That is, the content or process of the project does not fulfil the expectations for the shape of the project. For example, unforeseen problems may arise, or the project may begin to run over budget or over time. Engineers then attempt to shape the project, either by changing expectations about an acceptable shape for the project, or by getting the project back

into a shape that meets the original expectations. The term out-of-shape relates to the experiences of the engineer quoted here:

> Saying a project is 'going out of shape', is a really good way of expressing it, because that is how it feels.

Projects frequently go out-of-shape, as the following engineer discusses, although he uses a number of different phrases to describe this phenomenon.

> There is such a diverse number of ways that a project can become **unstuck** that it is going to happen, you're not going be able reach the stage where you can cover all the **problems** and swim on quite happily... ...You get better at coping with it and predicting, seeing the signs that the project is **getting out of control**, and then you can take actions to stop it going out of control, **derail**. There are very few jobs that go absolutely smoothly unless they are very small. (Emphasis added).

In shaping projects engineers apply their own expertise and the expertise of others to the particular situations (problems) presented by their projects.

5.2.1 Fitting

The process of applying expertise is described by the code *fitting*. The term expertise is used in a broad sense to include codes and legislation, scientific and engineering literature, the work of others such as experts and contractors, the knowledge and skills of others, and personal experience. Fitting incorporates the concept of technology transfer (Irwin, More, and McGrath, 1998). The process of fitting sits on a spectrum that ranges from the (hypothetical) concepts of *direct application* to *full creativity*. Direct application would involve applying expertise that fully applied to the situation, while full creativity would involve developing an entirely novel solution. Engineers tend to operate in the middle ground of this spectrum, where there is expertise that can be used, but is not directly applicable to all aspects of the engineer's work on the project.

> There are some codes that you can apply, but there is nothing that you can rigidly apply.

Working with borderline competence[14], or low experience relevancy[15], results in engineers working more closely to the full creativity end of the spectrum. However, even in Frank Ponder's design of Scott Base (Ponder, 1996), which he considers might as well have been on the moon, he still draws on the expertise of other people

[14] Borderline competence is a property of engineers' competence frontiers, as discussed in Chapter Four.

and his own experience, so it can still be considered a case of fitting rather than full creativity.

> I soon realised that I would have to start from scratch, and that I would be on my own. My next step was to consult with heating and ventilating engineers. They were very helpful and it wasn't long before I had the bones of a scheme in my mind. I had already decided any building would have to be prefabricated. I was well versed in prefabrication, having designed portable classrooms for the Education Board, portable buildings for wartime use, and portable timber workers' houses - designed to be shifted with the timber mills which provided timber to house the servicemen home from the war. Obviously in the case of buildings designed for Antarctica, inside air had to be heated and something done about the build-up of humidity resulting from human occupation. (Ponder, 1996, p.98).

Towards the other end of the spectrum, even if the expertise is highly applicable engineers still have to fit that expertise to their particular projects. For example, a structural engineer using prescriptive codes still has to "fit" a structure to the architect's concept for the building:

> A good architect will have a reasonable idea of a good structure, or what an engineer is looking for. We will try to fit a structure in that is appropriate, then it's a matter of organising the site investigation, analysing the results of that and coming up with a preliminary layout, sizing the members so that the architect can make sure that it fits into their concept of the building.

It is the idiosyncratic nature of each project that contributes to the need for engineers to fit expertise, and to the associated importance of performed situational competence[16]. The unique physical location and therefore social community of the project, and the unique combination of people and organisations involved in the project contribute to the idiosyncratic characteristics of each project. These idiosyncrasies mean that standard procedures and codes cannot be developed to cover all the concerns of engineering work. This point is emphasised in the following quote.

> While systematic observation and control procedures (such as regular testing) are essential ingredients for the successful completion of any project, they are not in themselves sufficient to ensure that success. With water retaining structures in particular, it is not possible to devise systematic procedures which will cover all construction aspects, and where unsatisfactory performance or failures have occurred in such structures, it has usually been the result of defects in the design or construction process which are not amenable to systematic quality assurance procedures. Opuha 2

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[15] Low experience relevancy is associated with project difficulty, as discussed in Chapter Three.

[16] Performed situational competence is a property of engineers' competence frontiers, as discussed in Chapter Four.

These idiosyncrasies also contribute to the frequency with which engineers are working in areas where they, and sometimes others, have low experience relevancy. As discussed in Chapter Three, low experience relevancy contributes to the concern with borderline competence. Engineers deal with this misfit between the demands of their projects and their experience by fitting expertise. In many cases this involves engineers making use of the expertise of others:

> I tackled defining the problem largely by getting information from organisations from overseas who have done similar things. Looking at not only how they have chosen to determine their problems but also how they have gone about solving them, the techniques and practices they have available... ...There are a lot of techniques that are used overseas, but what I was getting at is that a lot of it has to be New Zealandised: put through the New Zealand filtering frame of reference before any of it can be worked through. This applies from the planning process to the detailed design... ...Getting the international process into something that can be used is not really a structured process. You use a filter: what is relevant to where you are at, the environment you are in? For example, some international (overseas) processes were very detailed and involved huge resources to obtain all the information and develop it into a useful format. We don't have the resources to do that, it's just me plus a few draftees, and a few people obtaining data. It's taking the threads that are important from all this stuff you get from overseas, then it's a matter of working out what's relevant, what can be achieved in the time frames or resources that are available. And then putting out the result of that.

> So it was a pretty tricky problem. So once we had all that data I got in contact - no one really knew - I did some ringing around - no one had done any research on it. So I talked to a guy at (a research organisation) and said, 'who is the best person for this (topic)?' I found someone who knew a little bit about it. He said, 'the first thing to do is get some samples of ...'

> I got a foreman who knew a hell of a lot more than me about doing the job, I employed a couple of subcontractors to do various parts of the work, and I drew on experience from other project managers from around the country as and when I needed to. People I knew reasonably well, I'd ring them up and ask, 'what the hell do I do now?'

How highly engineers regard the competence of those from whom they are gaining information for fitting, affects to what extent they heed the advice of those people.

> ... I also know that the people that I choose to ring, (I) know whether or not they will give me a good answer or a trustworthy answer. So I trust their opinion, but if I think they sound hesitant I get a second opinion, so through that I feel that I have got quite a good resource of that experience to call on... ..It has become quite a reasonable issue (to know how wise their information is likely to be) in the jobs that I am doing because I am looking after (an asset) and I am not a (that type of asset) engineer, I have a background in the area but I am not a design engineer and I am not supposed to be doing the job that I am doing... ... and to be able to do know that when you ring someone that you get the right answer is so important because you may as well not ring them at all if you are not sure about the answer they may give you.

Describing all the techniques that engineers use in fitting expertise to projects is beyond the scope and focus of this thesis. In brief it involves developing an understanding of the project and its problems, and adjusting, synthesising, managing and evaluating the possible outcomes of the application of expertise to that project. Making assumptions, understanding models, evaluating existing systems, deciding which factors to consider, monitoring, assessing effects, developing options, and considering worst case scenarios are types of techniques that were evident in the interviews.

Engineers have scope to influence the shape of their projects because they are fitting their own and others' expertise to the idiosyncrasies of specific projects. While engineers are able to influence the shape of their projects they are required, and/or desire, to obtain the approval, or "thumbs up", from a range of people and organisations who are, or who may in the future, be involved in the project.

5.2.2 Thumbs-upping

Thumbs-upping is the property of shaping projects that describes the behaviour of engineers in their attempts to gain the approval of others for the shape of their projects. The approval engineers seek can be for the way in which the engineers think their projects should proceed, that is, their own perspectives of the desired shape of their projects, and for the formal approvals required by the project, such as consents being granted. Engineers' perspectives of the desired shape of their projects is often developed out of their fitting work, and so gaining the thumbs up is a reflection of the acceptance of that fitting work and hence their performed situation competence.

> I guess (the most challenging part of the work) is to come up with ideas that everyone can agree with. It has to be that good that it gets the thumbs up.

The extent of the need for approval is a reflection that projects that engineers are involved in provide a service for other people. In some settings the increasing need for that service to be accountable and useful to the people who use the service (through the increased requirement for public consultation, local government restructuring etc) has increased the need for thumbs-upping. The following quotes emphasise the importance of thumbs-upping.

> You will probably notice that we pretty quickly got onto the public consultation bit because you can't provide a solution in an ivory tower, just sitting down with a technical box and doing your own thing. You will come up with something but it may be miles away from being any use to anyone out there. So you are constantly out there, trying to see the problem through other peoples eyes, tailoring your investigations to suitably answer the questions that are being raised. You are tailoring your work to what is required.
>
> There is no right answer, but it was finding the one that would be most acceptable in this city and get the public support.

The level of formality in thumbs-upping ranges from legal requirements to get consent from an organisation or person, to engineers' practical or personal needs for approval. As an example of practical needs for approval, the engineer in the following quote describes his perception of the need for team acceptance of the project. This can also be viewed as a need to get others to take ownership of the project (project ownership is discussed in Chapter Seven).

> I need a chain of people after me to actually create physical change (in the system I design). There may be implicit discontent with my ideas, which is revealed in changes in design, delays. One might even say that it would be very unprofessional to do that sort of stuff but you still have got to realise in any organisation, no matter how wonderful your processes may be, you are still getting people to do it. And if someone doesn't consider a job as important as you do, it will get put behind other jobs, which they do consider to be important. It may not be an overt expression of, 'I don't want to do this job', but, 'it just doesn't stack up in my workload'. The whole work situation from planning to design really needs to incorporate team acceptance at some stage in the work. I did not understand the importance of this initially.

Thumbs-upping can involve balancing the need to gain support and approval from other people, with the engineer's need to feel comfortable with the way in which the project is developing. At times these needs conflict. An engineer may be quite flexible in working with the demands or expectations of other people, but in the end be quite firm about what he or she thinks is acceptable. In effect the proposed shape of the project has to get the approval of the engineer in addition to the approval of others. In the following quote the engineer is discussing consultation with ratepayers who contribute to the scheme the engineer is involved in designing.

> At the end of the process we aim for an area of common ground. The public says 'lets take the risk', and that's where we say 'hang on these are the risks that we are taking...'

At times an engineer may make a stand and refuse to do what the client or employer expects because the engineer does not think that what he or she is being asked to do is acceptable.[17]

> There was one instance where my boss said, 'well, our client wants it this way', and I said, 'no way, that is not going to be safe, you cannot expect me to propose something that I know compromises safety, I just won't do it', and he said, 'well fair enough'.

Thumbs-upping is undertaken primarily by discussing the fitting work that the engineer has been involved in.

> It's first of all coming up with a rational plan in your own mind and then bouncing that off people from other disciplines to get a consensus that that is a reasonable way to go.

> I have done quite a lot of research on the actual existing system... ...A lot of practitioners don't accept the facts - they still think the (part of the system) provides capacity. Being able to use the practicalities of life (data from an investigation of the system) has been quite nice (useful to gaining the thumbs up).

Engineers will often use their experiences with other projects in order to gain support for the current proposal. This is an example of the level of experience relevancy (of the engineer or others) being important to engineers' ability to use other expertise as evidence to help gain the thumbs up.

> To my knowledge this procedure has been, and still is, used at Macraes Mine on water and tailing Dam Construction abutment/fill interfaces. It was accepted by engineers on that project after trial as the best method of ensuring consistent rock abutment and fill bonding. Opuha 3

> In the next two years it (the project) was very successful, the contractors came up with innovative techniques. It went so well we could use it as an example for (a similar project). This helped us convince environmental groups to let us do it.

> When you see people using it in the way you intended it to work it certainly is a good feeling. It might help you with future projects as well. Because once it works somewhere, if it is a new concept you get to implement it somewhere else as well. It is easier to go through the decision making process because we can say, 'there is a working example here'.

Thumbs-upping can occur in a social way with different engineers working to back each other up in order to get others to accept their proposal. In the following quote a peer reviewer backs up another person's concerns.

> Both Tony Pickford and myself expressed reservations at the time of writing the above report as to whether there were adequate staff on site with the necessary experience and expertise, and suggested that some

[17] This was discussed in more detail in Chapter Three, Section 3.2.4.1.

> strengthening of the staffing in this area was desirable. I believe that the present problem clearly indicates a lack of such personnel, and rectifying the situation will necessitate enlisting additional supervision staff with the required qualifications... ...I share Tony's concern about the possibility of defective compaction zones at other interfaces, especially that at the sides of the diversion culvert. The Doug Hood letter provides no information on this aspect. Are you satisfied that from your own inspections and site records that there are no defective compaction zones in these other areas of the sort that we saw at the left abutment? This is the same question that Tony has already raised with you, so could I ask you to please send me a copy of your response to Tony's fax. Opuha 3

Frequent feedback is necessary to ensure engineers don't undertake work that won't receive the thumbs up.

> If you have further ideas that have not been covered in this report and that would be beneficial to a successful project please do not hesitate to contact me. Opuha 4

Engineers use a wide range of interpersonal skills to gain the thumbs up. Descriptors of thumbs-upping behaviours include discussing issues, facilitating, warning, reassuring, convincing, developing team acceptance, informing, arguing, requesting input from others, and gaining agreement on objectives prior to undertaking detailed design.

How well engineers get on with those people from whom they are trying to gain the thumbs up affects how easy it is to get the thumbs up. This is one reason why engineers put effort into relationship enhancing communication.

5.3 Relationship enhancing communication

Early in my study I identified that engineers put effort into attempting to contribute to the development of positive relationships with the people and organisations that were involved in their projects. Later, I found the phrase "relationship enhancing communication" (Wilmot, 1995, p.77) and chose to use this as the label for engineers' efforts to contribute to positive relations. Engineers' relationship enhancing communication skills can be considered important facets of their competence frontiers, because these skills aid their ability to get through difficult projects.

After engineers I interviewed raised relationship enhancing communication as an important issue in this study, I read Fletcher's (1999) work on relational practice. Her study of the relational practices of women engineers is based on relational

theory/psychology that had been developed by listening for, and to, the experiences of women (p.30). This theory involved the development of models of adult growth and achievement based on connection, interdependence and collectivity (Fletcher, 1999, p.31). The relational practices described by Fletcher (1999) are phrased in a positive way so 'relational practice' is essentially equivalent to the concept of relationship enhancing communication.

Fletcher describes relational practice as "intentional behaviour motivated by the belief that this way of working was a more effective way of achieving goals and getting the job done" (Fletcher, 1999, p.84). The concept of 'relationship management' also incorporates intentional behaviour and "challenges the notion that relationships evolve naturally and automatically or not at all" (Masciarelli, 1998). In the present study engineers held beliefs about the importance of relationship enhancing communication, indicating that their efforts to enhance relations were intentional.

I found that while relationship enhancing communication can be specific to the people involved in a particular project, engineers are often involved with those people in other projects also. Relationship enhancing communication can, therefore, be viewed as engineers influencing the social context in which they undertake their projects. This is consistent with Fletcher's (1999) finding that engineers try to maintain connections in ways that preserve the future growth potential of relationships (p.65).

Initially I will discuss the reasons why engineers in the present study consider relationship enhancing communication to be important. There are, however, some circumstances in which engineers do <u>not</u> consider relationship enhancing communication to be appropriate and discussion of such circumstances will follow. Techniques used for relationship enhancing communication raised in this study will be outlined, including references to other studies that have identified similar behaviours.

5.3.1 The Importance of relationship enhancing communication

Wilmot (1995) argues that relationships go through periods of stability punctuated by rapid change, rather than changing incrementally (p.64). Important to this view of relationship change is the concept of communication spirals, "where the actions of each person in a relationship magnify those of the other" (Wilmot, 1995, p.64). The possibility of either positive or negative development in relations was noted in a study of crises in construction management (Loosemore, 1997). Like Wilmot's concept of communication spirals, Loosemore (1997) noted that the positive or negative nature of relations tended to become self-perpetuating. Negative spirals involve relationships that have started to deteriorate, and continue to get worse and worse. In the present study putting effort into relationship enhancing communication was seen as a strategy for *avoiding negative spirals* and the difficulties they bring.

> Sometimes I prefer to take things on the chin, rather than launch into arguments because they grow.

In the following quote the engineer emphasises the importance of a problem solving approach that involves relationships of a positive nature among people involved in the project.

> It is absolutely essential (to contributing to positive relations with the people who are involved in the project) because if there is bickering and finger pointing and blaming, shifting the blame to others, you lose the team approach and create a lack of activity and the same with clients. It has got to be a problem solving approach. Because it is quite amazing when a difficult situation arises that collectively if people can talk it through, 'eh. there is another way around this', or it is not as big a hurdle as one side will see, so 'if you do this and that, then we will be able to get a step up' and you get over it or around it. And yes morale is crucial, both with the design team, also with contractors, because if they think, 'oh God, these guys don't do what they are doing?', the whole thing is a turnoff and I think their attitude slips even and they don't try and necessarily do a good job or see solutions themselves. You have got to have that positive attitude problem solving approach because (otherwise) you just end up in a stand off and reading the rules, contract documentation.

Engaging the freewill of others is another important reason why engineers engage in relationship enhancing communication. It involves engineers attempting to gain something from other people who have some degree of choice about whether they help or hinder the engineers. For example, in the following quote the engineer discusses the difficulty of obtaining information from people when they are not being paid to assist.

> One of the big difficulties is when your timetable for the project doesn't impinge in the same way on other people. So you have a job to, it has to be done in a certain time, you are dependent on getting information from somebody, they say, 'yeah sure', but don't deliver. You have to go back and say, 'look, I really did need that urgently'. They say, 'I'll put somebody onto it', and don't supply. In the case where you are paying for it you can go and thump on the table. In the case where you are not, it is difficult. So far I've found that networking and powers of persuasion are much more effective than jumping up and down.

Even when people are paid to undertake tasks, engineers find that people are more willing to be helpful if they have not behaved in ways that sour relations, as indicated in the following quotes.

> I work by consensus. Telling people what to do only works for a short time. Consensus means people are committed, but it takes time to get a consensus, but you do get a more dedicated team approach.

> I think you need to keep a positive environment, ...if you are in a tight position and you say, 'could you please do this?', and you haven't been mean to them all the way through, they are more than happy, that is what I found.

5.3.2 Situations where engineers limit relationship enhancing communication

While engineers emphasise the importance of putting effort into relationship enhancing communication there are circumstances when they refrain from such efforts, or even engage in behaviours which may result in a deterioration of relations. These circumstances occur when engineers have *expectations of ineffectual effort*, or when they perceive that *authority rules*, or in some cases when there is an existing *state of poor relations*.

Expectations of ineffectual effort are engineers' expectations that putting effort into relationship enhancing communication is unlikely to have a sufficiently positive outcome to be worthwhile. For example in the following quote the engineer didn't think she would be able to change the mind of the client so she stopped trying to improve the relationship.

> In the end I thought - because of that client I didn't think I would be able to change it, (so) I didn't make any further effort on the relationship.

In some circumstances behaviours for relationship enhancing communication may even be considered inappropriate to achieving desired outcomes. For example, in the

next quote the engineer considers behaviour that is not conducive to positive relations to be effective.

> If I think it is worthwhile (I'll put effort into contributing to positive relationships with people who are involved in the project), it depends on the project and the people too. Sometimes a positive relationship is not appropriate for the project either. If you need something from somebody in (another country), and it was supposed to arrive last week and it is not there - the project is more important than anything else, get on the phone and tell them about their mother in order to get it to happen.... ...If you say, 'listen I want that, I don't care what story you guys have got to put it on, you haven't supplied it, I want it on the courier, on the plane tomorrow', that is not generally a positive relationship at all but it is getting the point.

Engineers' expectations of working, in the future, with the people whom they could put effort into relationship enhancing communication affects their expectations. In the following quote the engineer attributes such expectations, and growing up, as reasons for his increasing efforts to contribute to positive relations.

> At one time if I was on a job and someone didn't like me, they could, 'go suffer', they were probably the words used... ...When you are working with a construction company it is basically a series of temporary organisations. I'm now in a permanent organisation with continuity and I've got to work with these people again. And also it is quite tiresome and you do grow up a bit.

Engineers can expect that their relationship enhancing efforts are likely to be ineffectual because *authority rules*. That is, either an engineer him or herself has the authority to make decisions, or someone else has the authority to make the decision and the engineer has little likelihood of influencing it. In effect, the perception that authority rules occurs in situations where the freewill or influence of people is perceived as limited. The engineer in the following quote raises the issue of authority rules. He discusses situations where he has authority to make decisions and this can limit how much effort he puts into relationship enhancing communication.

> But sometimes you end up in the negative situation where there is no resolution between the parties involved and that is the stage where the level of authority that individuals carry has to rule the day, I suppose, and I have some authority (in my job) over members of the public when it comes to dealing with (certain resources), so sometimes you are never going to be positive with people. You always bother, but you decide how much bother you do.

In the opinion of some engineers, those engineers who behave autocratically restrict their ability to engage in relationship enhancing communication.

> I know there are one or two guys at work that have got this superiority thing, that, 'I am an engineer and you do what I say'. And I have tried to

> stay away from that, I think that is a negative attitude, it doesn't help... ...you need to get their (people in the project team) respect through a way which isn't, 'I am the boss', for example.

Sometimes there may be *a state of poor relations*, where for example, people have a negative attitude towards the project. Depending on whether the engineer requires the approval of those people the engineer may decide to refrain from putting in efforts to relationship enhancing communication.

> Sometimes there are anti-people out there who make it their life's mission to be negative, so you are not going to get positive with them.

If an engineer perceives that other people who are involved in the project are not adequately fulfilling their roles, then this can result in the engineer losing respect for those people, and may limit the effort the engineer puts into relationship enhancing communication with those people.

> It was a very complex building, it really was, but the client changed his mind. I analysed the building 14 times and it was just a nightmare... ...it was just a pain in the arse and I lost a lot of respect for the client, and at the end of the day, and he wasn't paying his bills ... ...and he was happy with the result, but at the same time I was just, I was more in favour of the contractor at the stage, as I thought, 'well the contractor is going to be shafted as well'. And you know, it wasn't so much a ganging up with the client, but you know...

5.3.3 Techniques for relationship enhancing communication

Relationships involve trust, value and dialogue (Masciarelli, 1998). Three of the techniques identified in my study relate directly to these components of relationships: *establishing respect* (trust), *keeping communicating* (dialogue), and *contributing to other people* (value). *Being pleasant*, the fourth technique could be important to both trust and facilitating dialogue. These techniques will now be discussed.

Engineers may attempt to contribute to positive relationships by *establishing respect.*

> It is usually appropriate that you get on adequately with the contractors to some degree of mutual respect, and that they agree with what you are saying so you don't end up in arbitration, bitching about money, or bitching about the mechanism. It is appropriate that they understand what you are saying as if they think you are a fool or a villain, then the reputation of the project is likely to go as well. And you need to get on reasonably well with the client, you need to have the client's respect, you don't necessarily need the client to agree with you, you need to counsel the client, you might not agree with the client wants as well, but you need to have their respect.

Consistent with the finding that an established track record is an important grounding for relationships (Irwin, More and McGrath, 1998), demonstrating competence is

important to establishing respect. Miller (1998) found that women professionals adopted the strategies of learning and practising the masculine value system as a way of enduring and succeeding in the oil industry. This can be considered a way that women contribute to gaining and maintaining positive relations, by gaining respect from their male colleagues.

Trying to keep people talking, or *keeping communicating*, is an important technique for avoiding negative spirals. Keeping people informed helps to stop the build-up of misunderstandings, helping to ensure that other people have realistic expectations of the engineer's work and to develop realistic understanding of the factors that influence project performance. Honesty and humour can be useful to keeping communicating.

> I guess (I contribute to positive relationships) through communication, trying to keep people talking, a lot through jokes, trying to keep the feeling right and making jokes and things, but also trying to address any little issue, rather than (letting) it become large.
>
> (You need to) hold hands with the clients so they know what you are doing and why. This helps (them to have) realistic expectations (of your work and) if things aren't going well they know why. (Interview notes).

Keeping communicating by persistently requesting something from other people may be used to attempt to engage the freewill of others even though such persistent requests may not necessarily enhance the relationship.

Fletcher (1999) identified behaviours intended to enhance others' power and ability, and their achievement and contribution to the project (p.55), in other words behaviours that involve *contributing to other people*. For example, engineers tried to create a generalised experience of team by "attending to the individual – creating growth fostering conditions *within* people – and concern for the collective – creating growth-fostering conditions *between* people" (Fletcher, 1999, p.81). In the present study engineers, similarly, emphasised the importance of being interested in and helpful to others.

> You have to be proactive about helping them.
>
> It's important to help the clients to get where they what to go. And sometimes you do that in areas other than the project you are working on. With some clients I'll offer a bit of specialist advice, advice I've built up in

> the past. You know, just to help them in their position. And sometimes that's even with dealing with personnel issues, systems issues, things that you are not actually getting paid for... ...You don't want to ever be seen to be letting your colleagues down. If someone has asked you for help you do help them. Those people you build up a bit of trust with and trust is an important part of dealing and getting things done in an organisation like this.

In Irwin et al.'s (1998) study the importance of people liking each other, to technical innovation, was noted. *Being pleasant*, that is being polite and friendly, is an important technique for relationship enhancing communication.

> I was always keen to say gidday or you know, keen to keep a happy environment... ...you need to be their friend (that is, with support staff) and thank them.
>
> I try to keep it polite and positive at all times.

Relationship enhancing communication may involve engineers having to exhibit emotions that they do not actually feel. The display of particular emotions in the course of providing a service is known as "emotional labour" (Watson, 1995). Because emotional labour involves the control of emotions it can, itself, contribute to stress. Emotional labour is a problem-focused coping technique used to enhance or sustain relations. For example, engineers often talk about putting on a polite face for clients when really they want to tell them just how difficult they are being.

> A client I am also nice to, no matter what it is and how bad they are or whatever. And a lot of them have been pretty poor as far as their demands and what they are actually asking to change. You always come away from them thinking 'prick' or whatever, but I think in front of them you are always, you know, 'you are paying for this so you are going to get whatever you like, and I am going to try and do whatever you say'.

In the following quote the engineer has been involved with a "spiritual" issue which can't be dealt with "rationally", and therefore she feels that they are wasting their time attempting to deal with this issue. It does, however, form part of her role, and so she constrains the expression of her feelings.

> I felt like a stone between two rock sandwiches, you know (grinding gestures). It was a case to set aside, 'I think this is all stupid, why are we trying to do this nonsense?' And trying to keep that type of tone out of letters and talks that, 'I think we are all a bunch of idiots'. Which is terribly unprofessional but in actual fact was actually my own personal feeling about the thing.

In summary, engineers frequently, though not always, put effort into establishing and maintaining positive relationships with people who are involved in the project. Engineers undertake this effort because they perceive that it will make it easier to get

through the project and/or get through future projects. The skills involved in relationship enhancing communication can themselves be considered facets of the competence frontier. For example, Irwin et al. (1998) argue that personal communication is the core component of relational competence, and that relational competence is critical for innovation management and technology transfer. Similarly, the following quote from a civil engineering text emphasises the importance of relationship enhancing type behaviours.

> The construction engineer must at all times be a gentleman (sic) in the true sense of the word, with an active and sincere consideration for others... (It) is achieved by a determined and conscious pragmatic effort (Rubey and Milner, 1966, p.100).

5.4 Managing one's emotions

Due to the extent of emotional distress that can occur during involvement in difficult projects, engineers attempt to manage their emotions. Indeed, the ability to manage one's emotions can be considered a competence of engineers and thus a facet of their competence frontiers. So when engineers are developing skills in managing their emotions they are engaging in frontier building. Feelings of anxiety and frustration are commonly experienced by engineers involved in difficult projects, as presented in Chapter Eight. The stress associated with these emotions can be high. The following quotes discuss the importance of the ability to handle stress.

> I have to really distance myself from the work and try not to get so emotionally involved. It is like I haven't got enough - it is not so much that I don't care, it is trying not to: long hours, the emotion involved - and if it is not going to happen, just you know, 'well, see what happens tomorrow'.

> Some people work really well under pressure and some can't. And it's a matter of recognising where that's at because if you've got a key person who is going to freak out when too many bits of paper hit his desk, you need to know that to be a good manager. Recognising you are under stress yourself is difficult, and how to deal with it, and you need to... ...You have to recognise that a difficult project puts stress on you at work and potentially (it) will carry over to home and you need to let it go at home. It's a question of realising that, 'this job puts this much stress on me, I need some way of releasing that stress when I get home'. Not keep it internalised and go round and round like this all the time. Don't be a type A personality all the time.

The inability of engineers to work well under pressure was considered a quality that limited engineers' effectiveness, both by engineers and their supervisors (Newport, 1995, p.68). This gives further support to the importance of engineers' ability to

handle stress. Some engineers may not, however, consider the ability to handle stress as a facet of their competence frontier, as indicated by the following quote where the engineer accepts his tendency to get tense. Ultimately, however, if an engineer becomes too stressed then this would reduce the engineer's ability to shape the project.

> I always try and do a good job. It's just me. If it means I work a bit of overtime and get a bit tense and carried away and that's a character flaw, then so be it. That's a character flaw I don't mind having.

The term "self-management" is used extensively in the literature. While De Waele, Morval, and Sheitoyan (1993) describe managing oneself as meaning, "working toward the optimal integration of one's emotional, spiritual, intellectual and physical life" (p.8), the importance of managing emotions appears to have received little consideration from self-management researchers. For example, Williams, Moore, Pettibone, and Thomas (1992) describe a self-management scale that they believe reflects the use of both behavioural and cognitive practices that lead to good outcomes in life, yet their scale includes no questions explicitly relating to the management of emotions. Instead, their concept of self-management incorporates such features as the management of time, organisation of physical space and written plans for change. The focus of managing oneself in my study is instead on the management of engineers' emotional involvement in projects. This aspect of managing one's emotions has been highlighted in the interviews because of the emphasis on difficult projects.

The management of emotions is categorised into two properties: *getting on with the job*, which involves maintaining motivation despite ones feelings associated with the project; and *stress management*, which involves reducing the extent or intensity of one's emotional involvement with the project. Stress management is discussed further in Chapter Eight.

5.4.1 Getting on with the job

Engineers may have to put in effort to manage their emotions in order to be able to get on with the job. This may arise from engineers finding the work boring, that is they are not gaining in competence, or because they see the work as being too difficult. In effect, getting on with the job involves overcoming the tendency to

procrastinate. The tendency to procrastinate is discussed as a significant issue in dealing with difficult projects in Chapter Seven. Managing stress can be important to helping engineers overcome procrastination arising from fear that their projects are too difficult.

When engineers are faced with a difficult project they often have trouble getting started: they do not know how to go about the job. Engineers may overcome this tendency by starting their projects on some aspect that they do know about, or contacting anyone who may be able to help.

> I was given a set of documents, introduced to the client and told, 'go to it'. I had never put together a crew on a construction site or anything like that. I had to get a foreman. I launched myself into writing OSH (Occupational Safety and Health) and quality plans which was probably the side of the job I know a little bit about and then got the staff around me to do the job.

Engineers may overcome the tendency to procrastinate by putting in sufficient time to get the concern dealt with.

> I try and do a couple of things that I don't want to do every day. That's one of my ways of coping with it (procrastination).

The formation of and commitment to goals is a way of dealing with procrastination (Roberts, 1995), as discussed in the following quote.

> I've got this real nasty one (project) that I have put off and what I've said is that, 'once I've finished this other thing, I'm going to have to do that (nasty project)'. Tell myself that, 'it has to be done by a certain day...' ...I have a couple of places where I store my jobs and have one sitting right next to the computer than I can see all the time.

Being aware of the adverse consequences of procrastinating can help engineers to focus on prioritising their concerns so that they don't procrastinate.

> You realise that by not doing it (that is, by procrastinating on a difficulty), you end up in a power of shit and they have got to be done now. I think you have got to make that mistake at the age of about 25 and do it a couple of times. You begin to think, 'you need to prioritise and you do the important ones now, and you can procrastinate about the ones that don't need to'.

There can be times when engineers use how they feel about a project to decide to put off making a decision. That is, rather than just controlling their emotions, they use their emotional state as a source of information useful to guiding them on when to make a decision.

> I know that (procrastination) is a weakness of mine, but it is also a survival mechanism because if you feel that things are a bit in the balance or you are

> not quite convinced that you have got enough evidence to go down a certain path, it sometimes pays to procrastinate and sometimes the problem will actually go away which is wonderful. Sometimes it escalates, but invariably with a bit more time you can do a bit more reading or talking to someone else and get a bit more weight on one side so the balance will tilt and say, 'well I can go this far'. So it does help to procrastinate sometimes.

A lack of motivation was considered a personal quality that prevented engineers from being more effective (Newport, 1995, p.68). In the present study engineers sometimes described projects as having a "grind" or routine stage. This stage usually occurs when engineers know what needs to be done and just need to get on and do it. Engineers find this stage a grind because they are not learning and so their competence frontier is not advancing. No specific techniques for maintaining motivation during routine work were mentioned by engineers, although in the following quote engineering staff make it clear that they won't tolerate being given too much boring work.

> Large boring jobs - some of my staff have made it clear that if they don't get something new they won't be happy. There's a lot of grind in it and not a lot of enthusiasm.

A lack of positive feedback can make it harder to be motivated and to take ownership of projects, as discussed in Chapter Seven.

> It's harder to have motivation (when you are) not getting positive feedback (that), 'you are good at this'.

The anticipation of a holiday at the end of the project helped to sustain another engineer's involvement in a difficult project.

> I had every intent of running away to Hawaii for two weeks when it was finished. That was what was keeping me sane, 'hey, when this is finished I can leave!'.

Projects can drag on for a long time, delaying the satisfaction engineers gain from their projects. In the following quote the engineer increases her satisfaction by breaking the project down into smaller sections to form sub-goals. This may also be a way of dealing with the perceived difficulty of the work by making the job tasks seem smaller and more manageable.

> I absolutely adore ticking things off. I get a great sense of satisfaction from finishing a job. But most of the jobs that I have dribble on for ages so that's a bit frustrating. So what I try and do is break things down into smaller sections so that I can actually tick things off. So that gives me a great sense of satisfaction.

I have now described shaping the project, relationship enhancing communication and managing one's emotions as important competencies for engineers to get through difficult projects. Improving these skills can be conceptualised as engineers building or advancing their competence frontiers. A core argument of this thesis is that the processes of frontier positioning and connecting-project-and-frontier are also important to the ability of engineers to get through projects. Before presenting these processes in Chapters Six and Seven, however, let us turn to the outcomes emphasised by engineers that result from getting through difficult projects.

5.5 Experience gains

The reality of organisational life is that people tend to learn more from informal mentoring or being thrown in at the deep end than through formal training (Guest, 1997). For example, Kaufman (1974) found that technically challenging work in engineers' initial job experience significantly contributed to professional competence and job performance as much as 14 years later. He attributed this to good initial performance resulting in further challenging assignments and a continuous process of positive reinforcement. Similarly, in the present study engineers frequently emphasised the experience they gained from involvement in difficult projects. Experience could be gained whether a project went well or went badly. Indeed, engineers often found that they gained very significant experience from projects that went badly. Experience gains equate to engineers gaining competence and hence their competence frontiers advancing.

> I learnt things as I went. I did quite well on that project, made a large profit, so that was a successful project. I came up with a couple of ideas about doing things differently which gave a lot of the profit margin. I think I improved on running the job from when I started to when I finished. When I finished I was quite happy that I could go onto another job and correct the mistakes I'd made, and improve on some of the improvements I'd made.

The experience gained may range from matters of a technical nature, to techniques for relationship enhancing communication and thumbs-upping and learning how to manage one's emotions. Engineers may learn both what to do, and what not to do.

> One thing that I learnt was that you hit the ball running in construction. Every hour of every day lost in the beginning is stuff you have to catch up in the middle and it's really difficult to do that. So rather than feeling my way into it, which is what I did do, I should have dived in straight away and

> got things going. Perhaps spent a bit more money creating that time for myself. It should have been a job that finished well within time.

Engineers can feel that their experience has improved through personal experience of problems, even if they knew theoretically about such problems prior to them arising.

> This one really rounded out my experience. There were a lot of things that I knew that could happen, that did happen on this one. You don't expect a problem, but you run into it.

Experience gains may incorporate *reflective learning* (discussed in Chapter Six) but it is not limited to conscious thought on what went right and what went wrong. Experience gained may be explicitly understood and recognised, or may be a more general sense of greater ability to cope with difficulties.

> There are personal strategies I have learnt, by osmosis as much as anything, I couldn't tell you what they are, but things are easier now than at the start.

A significant increase in experience tends to give engineers greater confidence in taking on other difficult projects. They may even actively seek out such projects.

> As you tackle harder and harder projects and do well at them you realise that you have a knack for it. So they are the ones you actively seek out more and more.

On the other hand experience gained through involvement with a difficult project may influence engineers to avoid such projects, even contributing to them to leaving their job or job position.

> It was an *interesting* project but not something I would want to go through again. And by that time I had just had enough of the political nightmare that went along with it. I can't say it caused me to quit but it was a contributing factor.

As discussed, gains in experience reflect that the engineer's competence frontier has advanced. These experience gains emphasise the importance of on-the-job learning. This is consistent with a study in 1967 of 290 Research and Development scientists and engineers, where on-the-job problem solving was the most frequent response (42%) to the question: "what was the most fruitful learning experience you have had over the past year or two?" (Dubin, 1972, p.396). MacGibbon (1999) also found on-the-job learning to be significant to volunteers working for a women's refuge, and she raises the resulting concern of the potential for the organisation to fail to provide its service to the desired standard. In many circumstances this concern for the potential for poor service, that is, the fear of being incompetent, underlies engineers' concern with borderline competence.

5.6 Relationship development

In addition to experience gains, engineers emphasise relationship development as a consequence of getting through difficult projects. This may be either positive or negative development in relationships with the people who have been involved in the project.

> The engineer worked on a number of similar projects with the same contractor. As they gained experience they knew what to look for and developed good rapport. The contractor would ring her up if anything needed her attention/advice. These projects seemed to be a very positive experience for her. (Interview notes).

Even when projects have gone significantly out-of-shape relationship development can still be positive. These project difficulties can provide opportunity for engineers to exhibit considerable honesty and competence in getting the out-of-shape project back into shape, resulting in others gaining trust in them.

> And I think what I have really learnt in that period is that it is extremely important to put things right, if you put things right your client will have to forgive you in the end.... ...And what you do after a while is be brutally honest with them. And honesty is a great virtue... ...So they'll accept you with your failings, because on balance they enjoy working with you. And for them to enjoy working with you there has got to be a measure of honesty there.

Trust and co-operation often characterise relations between people who have been involved in a project. Future projects the engineer undertakes with these people are likely to go smoothly. In effect the engineer's future support situation is improved.

> Having completed that project and achieved the backing of the director I worked for - if I needed him there at three a.m. photocopying he would be there and I was a graduate maybe two months ago - you pretty quickly clicked onto the fact that the support was there. And that enabled me to develop a very full relationship with my boss. We moved on (to other projects) to the extent that for the next four years we were able to rely on each other pretty much entirely. He might ring me at ten or eleven p.m. and say, 'I've got a problem', so I'd go in and help him out, and vice versa.

In other situations engineers may decide that they never want to work with a certain individual or organisation again.

> Often (I might feel as my involvement in a project ends, that), 'thank God that is over', or, 'thank goodness I don't have to deal with these terrible people again!'.

Engineers will often avoid working with people or companies as a result of bad experiences with previous projects.

> Oh (we do turn down offers of employment occasionally)... ...and it can also be some clients where there have been difficulties with the client, and

> you say, 'well you won't bother going back there', so we do turn work down.

It can be particularly concerning for engineers if a relationship that is considered important for future work has become poor.

> I've been feeling the client has 'dipped out' of a lot of the political agreement. Feeling the client is on a completely different wavelength to you on some things. It's affected the development of an important relationship.

In summary, relationship development occurs through being involved in a project with other people, and the nature of the changes in the relationship are important to future work opportunities and social support for getting through projects.

5.7 Conclusions

Engineers build their competence frontiers through involvement in projects. A wide variety of competencies are important to the ability of engineers to get through projects. Engineers need to get through projects not only by fulfilling the practical requirements of their roles, but also by getting themselves personally, that is, emotionally through their projects. In this chapter a range of competencies that have been raised as important to the ability to deal with difficult projects have been discussed. These competencies should not be considered a complete analysis of all the types of competencies required by engineers. They do, however, indicate the wide range of competency types that are important.

The outcome of relationship development that occurs as a result of project involvement influences engineers' support situations, which were discussed in Chapter Three as an important influence on project difficulty. The outcome of experience gains is an indication that the competence frontier has advanced. The frontier positioning process establishes whether or not this advance has occurred as described in the next chapter.

Chapter 6
Frontier positioning: "have I done a good job?"

6.1 Introduction

Arising out of engineers' experiences of frontier building (described in Chapter Five) are cues that implicate their competence. Engineers think about these cues in assessing the state of their competence, that is, they position their competence frontiers. This frontier positioning process is indicated by the in vivo code '*Have I done a good job*?'. It occurs concurrently with the processes of frontier building and connecting-project-and-frontier. In some instances frontier positioning is a mechanism for coping with the emotional stress of being involved in a difficult project by *assuring competence*, which is a concern that can arise from the connecting-project-and-frontier process as discussed in Chapter Seven.

In the present chapter frontier positioning is related to theory on self-identification, then the nature of *competence implicating cues* that arise from the frontier building process are described. The techniques of the frontier positioning process are presented as *assessing competence, influencing others' images of one's competence* and *reflective learning*. The outcomes of frontier positioning are described as the *affirmation or adjustment of the competence frontier position* and the formation of *proactive plans*.

6.2 Frontier positioning and self-identification

A property of competence frontiers is that they are part of engineers' self-concepts, as described in Chapter Four. Mead (1934) divided the self into the 'I' as the experiencing active being and the 'Me' as the person's perception of him or herself as an object (Howard and Hollander, 1997). Self-identification involves the 'I' reflecting on the 'me'. Frontier positioning is a self-identification process where engineers alter or affirm their self-concepts (the 'I' reflecting on the 'me') of the approximate position of facets of their competence frontiers (a part of the 'me'), that is the *competence frontier position*.

The 'me' and the 'I' can also be associated with the structure (the 'me') and the process (the 'I') of the self (Markova, 1987). The structure refers to the relatively stable nature of the self, while the process refers to the changing nature of the self. At least some engineers have a fairly stable self-concept of being competent.

> He's a real tough diamond, like he's got the scars, he's got tatts on the neck, on the hands, he's a tough boy. He voluntarily calls me leader. So over the years I have earned his respect and he calls me leader because, because I am. And that's the way it is.

The common underlying concern with difficult projects is described in Chapter Three as the opportunity for engineers to enhance their competence with, however, a risk of being incompetent. In effect, difficult projects are likely to provide situations where engineers need to reassess those aspects of their self-concepts that form their competence frontiers. For example, competence-implicating cues are often evident when projects run into difficulties.

> It was embarrassing going past the welders. I don't speak the language, but the workers were looking at you like they think you are mad.

The frontier positioning process is normally initiated when cues that result from the frontier building process implicate an engineer's competence. That is, the competence frontier position tends to be changed or reaffirmed through demonstrated rather than inherent competence, as reflected in the property (of the competence frontier) performed situational competence. In the previous chapter significant gains in experience were noted as a consequence of involvement in difficult projects. These gains indicate that at least some facets of the engineer's competence frontier have advanced. Frontier positioning involves the engineer recognising these gains. Frontier movement may be either backwards (to lower competence) or forwards (to higher competence). The frontier movement may occur in any of the facets of the frontier.

Positioning the frontier is important to engineers because they gain self-knowledge and because processes involved in frontier positioning are useful in providing feedback to the frontier building process. There are three main types of motivation that affect self-knowledge: appraisal, self-enhancement and self-consistency (Baumeister, 1998, p.688-689). The appraisal motive is the desire to learn about oneself, which incorporates a preference for accurate feedback (Baumeister, 1998,

p.689), for example, engineers want to know how competent they are. Self-enhancement involves a desire for favourable information about the self (Baumeister, 1998, p.689), for example engineers' concern with advancing their frontiers. Self-consistency is the desire to confirm what one already believes about oneself (Baumeister, 1998, p.689), for example, that one is competent.

In addition to motives for knowing oneself (the appraisal motive) and perceiving oneself in a positive and stable way (the self-consistency motive), people are also motivated to exert control over both the self and the environment (Baumeister, 1998, p.712). Frontier positioning can involve processes focused on learning for the purpose of improving one's ability to get through projects. For example, the strategies of *assessing project performance* and *reflective learning* can enable engineers to develop *proactive plans* for how they will alter or continue their current frontier building efforts, or tackle similar problems in the future. The frontier positioning process therefore serves the dual concern of engineers discussed in Chapter Three, the concern for the self and the concern for others affected by the project.

6.3 Competence-implicating cues

Engineers are frequently exposed to competence implicating cues, which tend to be qualitative and evident in the decisions and communication of people around the engineers. Cues may be deliberately sought after by engineers or be presented to them incidentally. An engineer's competence is usually assessed, at least in part, by the performance of the whole project, or that part of the project that the engineer is involved with. This means that much of the information that pertains to the performance of their projects is of interest to engineers, as it is useful in establishing their own competence. The following quote is an example of competence-implicating information given by a peer reviewer who was involved in the Opuha Dam.

> The above defect is a very serious matter as it could lead to large seepage quantities and possibly to internal erosion within the seepage control zones, and I am naturally very concerned that fill placement has proceeded as far as it has without this problem being identified and rectified. It should not have taken a visit by peer review personnel before such a problem was identified. Opuha 3

While engineers receive a lot of information that may implicate their competence, most of this information is not explicitly or directly about their competence. This contributes to engineers' competence uncertainty, which was described as a concern of engineers in Chapter Three. There are many factors outside their complete control that affect how well a project runs, yet how well a project runs forms the basis for much of the evidence used in assessing their frontier positions. The lack of explicit information on their competence encourages engineers to be tuned in to all information that could allow them to establish to what extent they are competent.

> If I have designed something that is (implemented and I travel past) it (I) have a look at it and see if a good job has been done or see if I have done a good job. People raise comments about it, and if I have done it either present or past, (I) take that on board, yeah. I often take a look at it - well I take what I do very very personally so any comments that come back in any form are taken on board and reflected upon, yeah.

Part of the context of being involved in projects is the highly relational nature of the work. The significant number of people and organisations who can comment on engineers' frontier building efforts results in many competence-implicating cues. The highly relational nature of engineering is important not only because it increases the number of cues that encourage engineers to position their frontiers, but also because self-concepts are highly correlated with how we believe others perceive us (Baumeister, 1998, p.701). Frontier positioning is an example of the social process of people retrospectively making sense of their recent experiences, which is termed "sense-making" (Weick, 1995). In effect, an engineer and others attempt to make sense of the engineer's involvement in a project in terms of the engineer's competence.

> Being able delivers the goods on time, that would be one way (that my competence is) assessed by the clients, whether I am meeting the deadlines that they are requesting and (their) suggestions. The contractor who is doing the day to day operation who in the past I have been responsible for, they would be assessing my competence through how quickly I can make technical decisions and that I am making the right technical decisions, more of the technical view point. My boss is probably judging my competence by how many problems my work is creating and that the client is happy with the work I am producing. And peers in the office would probably be judging my competence by the feedback that they are having from the contractors.

People circulate information about their perceptions of individual engineers' competence, even if this information is not given directly or explicitly to those

engineers, so engineers can be faced with a climate of social innuendo about incompetence.

> I think that side of it is part of the (employer's) performance standard thing, you know where they do expect you to perform and if you are not seen to be performing then they do have sort of subtle ways of making you feel inferior you know.
>
> But the thing is what people say behind your back.

Competence-implicating cues tend to occur on a fairly continuous, or event by event basis, although engineers can go for some time with little feedback that implicates their competence. The following quotes describe engineers frequently processing cues that implicate their competence.

> I guess I look at what technical work people have done and assess whether that meets what I understand to be necessary technical standards for (the subject of my job role) in particular. And if (their work) doesn't come up to scratch and there is no particular good reason why, then I sort've assess my own level of skills as being better, than these people involved. Sort've works that way really, if people come up and extend my ideas that I hadn't dreamed of which are better (than) I have been working (on), then basically I would say, 'that is better than me in this particular circumstance'. So it is a really sliding scale all the time and it happens on an event by event basis really: some people do things better than I do occasionally, and the same people can do things woefully sadly, sometimes, you know, and sure I am sure it's the same in respect to everybody else.
>
> You are challenged very often as to what you do and why you do things. I can imagine that working as a structural engineer you could go unchallenged for weeks, whereas in (my field of) engineering you just get challenged all the time so there is just no chance of not knowing whether you got it right or not.

Engineers tend to work in settings where there are colleagues who are at a sufficiently similar career stage that they represent a benchmark against which the engineer can compare his or her competence. This further contributes to the presence of competence-implicating cues, which can then contribute to engineers' concern with being competent. The use of colleagues as sources of cues about engineers' competence is discussed in section 6.4.5.

Many projects go through a number of review, consent or checking processes and this also contributes to the extent of feedback pertaining to competence that engineers receive. Often feedback on a project will not occur until the project goes through a process where other people view it. Competence-implicating cues tend to occur most around such times.

Projects with a high public profile and those projects that involve public consultation can involve many competence-implicating cues, which are often emotionally charged.

> You know, (you have a) shitty day, and you have got x number of submissions in on an application saying, 'you are a dork, because you have wrote this or that' - not that they would really say that - and you will take it home and say, 'got this horrible day at work, people hate me'.
>
> If anything goes wrong with that job you're under pressure. Your name is in the paper, your face is in the paper, and wherever you go people ask you what the hell is wrong with that (system), they'll stop your wife in the street. It can get pretty tiring in a town of this size.

In summary, the many people who observe engineers' involvement in projects (that is, engineers' efforts at frontier building by getting through their projects) can be sources of competence-implicating cues. Engineers think about the relevance of these cues to their competence. The processes involved in engineers assessing their competence will now be described.

6.4 Assessing competence

When asked how they assess their competence most engineers paused for some moments before answering. One engineer felt that he did not know the answer to this question. The time engineers take to formulate an answer to the question may reflect a lack of conceptual labels for describing the processes, or that the processes are not conscious. Assessing competence is undertaken by *assessing project performance, performance attribution, comparing performance to process expectations, establishing expectations, collegial comparison, reassurance seeking, questioning competence-implicating cues*, and *tuning in.*

These processes may occur in isolation or in conjunction with each other. Most of these strategies are based around assessing competence through project involvement. Engineers may get other more general indications of competence, such as promotions, registration, or when people approach the engineer for advice, which is often interpreted by engineers as indications that they are considered competent.

6.4.1 Assessing project performance

The main way that the competence of engineers is assessed is through their work on projects. The association between their competence and project performance often

remains implicit, and so engineers' competence, or at least lack of incompetence, is evident in aspects of project performance. For engineers to assess their own competence they need to assess the performance of the project that they are working on. Assessing project performance involves comparison of the project to norms or standards. These standards may be the engineer's personal standards, established expectations of the project's performance, or standards of the client, employer, profession, public or consent authorities. The approval or disapproval of the project by other people, such as peer reviewers (whether formal or in-house), clients, consent authorities and the public is also important to assessing project performance.

The success of a project is often phrased in terms of how "smoothly" the project runs. "Smoothly" incorporates such factors as whether the project was completed on time and within budget, to what extent the engineer's superiors had to help to resolve problems, and how happy the client and contractor were.

> Every time the phone rings and people shout, that is about the best way of (assessing my competence). I mean if a project goes smoothly and the client is happy and your contractor is happy, and the engineer is happy, that is a reasonable good thing and I mean a number of projects have technical blips in it... ...but provided it doesn't fall over, it is done for the right amount of money and the client is happy in the end, and nobody got screwed by necessity, I guess that is the success of it.

In a study of architects it was found that assessing the work as it progressed was an integral and ongoing part of their work (Schon, 1983). While an engineer is likely to be assessing the project continuously the other assessing competence strategies tend to be used on a more intermittent basis. That is, the engineer may assess the project without going on to further cognitive processing necessary for positioning the competence frontier.

6.4.2 Performance attribution

Attribution processes where individuals attribute their successes and failures to internal stable characteristics or external factors are widely recognised in the literature, see for example Antaki (1982) and Hewstone (1989). Similarly engineers make attributions of the factors that influence project performance, and the factors that influence their own performance. These cognitive attributions are described in the present study by the term 'performance attribution'. In effect, performance

attribution is the process in which engineers decide to what extent the project performance is a reflection of their own competence. It involves establishing to what extent different factors affected the performance of the project, and further to what extent the engineer was able to, or should have been able to, control those factors.

> It was getting a week afterwards you know the issue date, and I still hadn't produced anything, but it wasn't because I couldn't do it, it was because I was doing it may be too thorough. And he (the boss) took me aside and asked me what I had done, and gave us (the draughts-person and myself) a real big rev up as to, 'why are you doing it in such detail?', he said, 'it is only a small fee' and whatever else. If he had've told us that we would have known from the outset, but we didn't know.

> Sometimes we have failed. Failed to convince the public, failed to convince the councils. When I first started off I used to take that really personally, I used to think, 'damn, I could have done better, why didn't they listen to me?'. These days sometimes you just have to accept that its nothing to do with the logic that you put up, it's just that the time wasn't right, people you are trying to convince may have been scarred by a previous event, and you put that down to experience, think 'could I have done things better?', and if you could do that next time, but yeah, move on.

The process of performance attribution may range from the private thoughts of individuals, as indicated by the two quotes above, to explicit arguments between the different groups involved in the project as discussed in the following quote.

> The project had major cost blowouts and it was our view that the contractor had really exploited the fact that there had been a break between the consultants and between those two phases. They supported that to the hilt, however consultant B blamed consultant A for all the problem that occurred on site, and so it was a three way circle, with the client in the middle saying, 'well, I don't know who to believe'.

This means that performance attribution can be a social process. Other people may contribute to the performance attribution process by describing the factors that they think contributed to (poor) project performance, as shown in this communication to the construction contractors of the Opuha Dam.

> The material has segregated and permeable zones at the interface resulted. Fortunately this was identified by the peer reviewers during their visit last week and has been rectified. The fundamental cause of the problem is the lack of sufficient experienced people on the site and I understand some action is to be/being undertaken by both Hood and T&T. Opuha 4.

Performance attribution may include "external attribution" where people attribute the cause of something to an external source (Antaki, 1982, p.6). In terms of the present study, external attribution is the process of engineers deciding that factors external to their control caused or contributed to a project going out-of-shape, or them to perform poorly. Many factors that influence projects can be considered on the verge of the

engineer's control. External attribution allows engineers to see their competence frontiers as unaffected by poor project performance. In the present study it appeared that external attribution was an important way for engineers to cope with involvement in projects that did not perform particularly well, or in situations where their performance was not meeting their own expectations or others' expectations. For example, in the following quote the engineer has trouble getting the project done in a short enough time and attributes this to the large number of small elements to the project.

> But for this other project which was actually the design of a little wee (facility) the input from senior staff was pretty minimal and that was really because it was perceived as a little project but there were lots and lots of elements to it, which meant it was - although the actual design side of it was easy there was a lot to cover... ...For something that was really such a small project there were lots of fiddly little bits you know. And in themselves they would only take a matter of a day or so to solve, but because you were dealing with lots - when you listed them out it doesn't sound like a lot - but because you are dealing with several of them it made it a bit of a - complex is not the right word - but a fiddly project.

Personality traits can influence attribution processes. For example, some people have a *deficiency focusing interpretive style*, where they tend to attribute failure to stable internal characteristics of the self, and success to external factors, while others have a *skill recognition style* where they tend to interpret success as due to their skill and failure to external factors (that is, external attribution) (Thomas and Tymon, 1995). The interpretive styles are significantly correlated with individuals' self-esteem, with higher self-esteem individuals more likely to have a skill recognition style (Terry, Tonge, and Callan, 1995). For example, there were indications in the present study that engineers with lower self-esteem may be more likely to blame themselves for projects that didn't go well, as indicated in the following quote.

> If he indicates that he doesn't think I have performed well on a job it can - really it depends, if you have got two or three projects like that that just don't happen to be going really well at the time it can end up feeling that, you know, - you really shouldn't be doing engineering after all.

The skill recognition style reflects the desire for self-consistency. This motive is thought to reflect our desire for predictability and is associated with people being unwilling to change their self-concept (Baumeister, 1998, p689). Engineers who perceive themselves as highly competent may be very reluctant to accept cues that

indicate they are not competent. They are more likely to blame failure on factors outside their control (that is, use external attribution).

> Now it is most difficult for somebody that regards themselves as highly competent, that they are really top of their profession and a lot of people find a great deal of difficulty in actually, I guess identifying that they have made a stuffup, that it wasn't right, it wasn't the right solution, and we do have difficulty with people who will never actually admit to that.

Personality traits can influence individuals' preferences for tasks that reflect (or do not reflect) their competence. For example, people who have an *uncertainty oriented disposition* prefer tasks that diagnose abilities about which they are uncertain, while *certainty oriented* people prefer tasks that confirm abilities of which they are certain (Sorrentino and Hewitt, 1984). This suggests that uncertainty oriented people place great emphasis on self-knowledge, that is, finding out how competent they are, at the potential short-term expense of self-enhancement and self-consistency, which may occur if they are shown to be less competent than they thought or desired. In assessing ability, for example, an individual may incur a short-term loss of self-esteem for the sake of its long-term enhancement (Trope, 1986, p.374). Some engineers in the present study expressed a desire to work fairly autonomously, suggesting an uncertainty oriented disposition, or a desire to take credit for a project that goes well. For example, the desire to work independently can be a strategy for increasing the extent to which the performance of a task reflects the worker's performance (Trope, 1986).

> Well I kind of work within the group but I am not - but I don't work particularly closely with large teams of people. I tend to work by myself, generally for clients that I have a long relationship working with. I am the point of contact and I carry out the bulk of the work. I do my own stuff and everyone kind of recognises me.

In summary, engineers engage in cognitive processes of attributing the performance of their projects to a range of factors, which may include their own performance. The more the performance of a project is attributed to an engineer's performance, the more effect it will have on the engineer's perception of his or her competence frontier. Personality traits of individual engineers may influence how likely they are to attribute the project performance to their own performance rather than to other factors.

It is not just the performance of projects that are important to assessing engineers' competence. The actual processes that engineers use in their work are also important, and this is described by the code 'comparing performance to process expectations'.

6.4.3 Comparing performance to process expectations

Comparing performance to process expectations involves engineers' performance being assessed according to whether they follow the processes or procedures appropriate to their projects. This may be particularly important in organisations that place considerable emphasis on procedures.

> People (who) are involved as part of the team environment that I'm supposed to be working in will look largely at the process thing that is going on. Say if I talk to them about right issue at the right time, or have I ignored their input, or I have missed this constraint or that particular issue? Then that level of competence is sort of assessed by the people around me at that time. And I realised when I first came into this job and I had a particular job to do, that I basically ignored all of the standard (employer) processes and just planned a project, and figured out what I thought was necessary and got it done. And I stood on a few toes, and pissed a few people off, but I ended up getting it done. But now some of the project values are creeping up quite high... ...as I said, where ignorance and confidence doesn't really work very well - and so you have to comply a little more. Ahh, and I guess it is a matter of drawing the fine line between if you want any work-mates to believe you to be competent and successful and therefore choose to work with you, or whether they think you are ah, I don't know, a bully or ignoramus or stupid and choose not to.

Assessing an engineer's competence on the basis of the processes they follow is more likely when people recognise that the engineer doesn't have full control over all the factors that influence project performance.

> Perhaps the boss thinks you have attempted consultation (and) they are experienced, and they understand what you are doing and the problems that you are likely to have with the public... ...(So the boss assesses your competence based on) whether or not you have taken all the steps that they would have gone through in your situation.

Identifying the processes that should be followed constitutes engineers establishing an understanding of expectations. There are many types of expectations, in addition to processes that should be followed, that are important to assessing performance, and these are discussed next.

6.4.4 Establishing expectations

Judgements of success and failure take place within a frame of reference, including factual points of reference and acquired (self-)guides (Higgins, Strauman, and Klein, 1986). That is, engineers position their competence frontiers relative to their own

standards and norms and those of relevant others. Establishing expectations is the process whereby engineers develop self-guides, which may include ideal-own, ideal-other, ought-own and ought-other self-guides (as discussed in Chapter Four[18]), or expectations of project performance. In the following quote, for example, the engineer and his boss have "benchmarks" which they use for assessing the engineer's performance.

> I guess I look for affirmation (of my competence) through our personnel appraisal system. We make sure we have regular interviews two or three times a year where I can have the opportunity to talk with my boss and (he/we?) benchmark progress in certain areas, he evaluates my progress against those benchmarks. So that is a very valuable process.

There are usually many important standards for aspects of projects and their performance, such as the requirement that the environmental effects of a discharge be modelled, as emphasised in the next quote.

> There used to be a cook book method, for assessing if the discharge can be made, but the (consent authority) won't accept that anymore. So you have to find out how much (discharge) is coming out. ... ...I spoke to the (consent authority) about exactly what they wanted, and it turned out that they wouldn't accept the old way of doing it, they said they had to have modelling.

The types of competencies desired or required by an engineer tend to change from project to project, and through engineers' careers, as consistent with the importance of performed situational competence[19]. Many professional and organisational norms and competencies are not explicitly explained to young engineers. They learn the importance of these norms and competencies through experience. Thus for each social setting and each project there are likely to be different expectations. For example, engineering projects often require public support and approval, so it becomes important for engineers to understand the expectations of the public.

> Here's something that hasn't really been done before. Let's sit down and decide what we need to know. Has anyone else done anything similar (find out how they would do things differently, and find out how that applies to your own area.), **what's the public reaction going to be** and how are we going to tackle it? The key to those projects is to start on them soon enough, so you can gather data**, turn public opinion around and so on.** That's what we did with (a project). Looking at what other people have done, also with (another project). **There is no right answer, but it was finding the one that would be most acceptable in this city and get the public support.** (Emphasis added).

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[18] Section 4.2

[19] The property of the competence frontier that engineers need to perform in the many different situations that project involvement places them.

While engineers may need to establish expectations by seeking out people views, in some cases other people will give explicit expectations to them. For example, in the following quote the peer reviewer gives explicit directions for inadequate practice.

> Existing construction practices are resulting in the creation of a potentially highly permeable and erodible contact between the sub-core/core materials and the left abutment area. Obviously the existing construction practice adjacent to the left abutment area and the current level of on-site supervision are inadequate. The identified defective materials, and any other suspect materials adjacent to the foundation and/or diversion culvert, should be removed and replaced with more appropriate materials. The existing materials may require screening to remove the coarser sizes and hand compaction methods may be necessary to achieve the desired result adjacent to the abutment and concrete surfaces. As recommended earlier, additional experienced on-site supervision should also be enlisted to control the placement of embankment materials in critical areas. Opuha 3

Establishing expectations can involve finding out what the expected processes of an organisation are. As performance is often assessed in terms of processes used in addition to project performance, an engineer who has not yet learnt what those process expectations are, may be considered incompetent even if the project went well. See for example, the first quote in section 6.4.3.

Some engineers have ideal-own expectations that reflect their personal values, such as concern for the environment or maintaining high technical standards. In some cases engineers may actually be unwilling to take on the expectations of others, and what they actually do depends on their own expectations rather than the expectations of others, as discussed in Chapter Three[20].

"Pre-competence" involves incompetence that is considered to be temporary and due to inexperience, so pre-competent people are often told not to take their failures seriously (Langer and Park, 1990; Sternberg, 1990, p.151). Similarly, inexperienced engineers may be told, or feel, that they should not take on too much responsibility for project failures.

> Sometimes there're situations where you can't avoid being under stress so you just sort of have to deal with that as you go along. I think that it is easier when you first start out as well because you can say with a clear conscience, say, 'I'm just learning the ropes here (so I) can't really assume too much responsibility'.

[20] Section 3.2.4.1

The performance of meaningful others can act as factual reference points to which the individual can compare him or herself (Higgins et al., 1986). For example, in the following quote the engineer observes that engineers who only take moderate ownership of projects tend to do better than those who become overly emotionally involved, in which case the ability to take only moderate ownership of a project becomes an ideal-self guide.

> They (my employer) really expect a lot and that is difficult. In some ways it has some real benefits. It means that you aim very high, which I think is probably a good thing so long as you realise you are doing it. The problem is when it does start affecting your confidence and when you get too caught up in that whole (employer) perspective and can't step outside it. If you can keep it in balance then I think you are OK, and probably the more successful people at (my employer) do that. I think the people who find it hard are the ones who tend to take it too seriously and that is - because I am sort of trying to crossover from one category to the other I think - and I am sort of somewhere in between so... ...And really we do take ourselves very seriously because it does have some benefits but it is not, you know, the definitive way of looking at life.

In summary, establishing expectations involves gaining and interpreting information to form an understanding of their own, and others, expectations of the project's performance and their own performance. The performance of reference colleagues is a significant method for establishing expectations and is presented by the code: collegial comparison.

6.4.5 Collegial comparison

Social comparison, that is evaluating oneself in comparison to others, plays a central role in developing one's self-concept (Stephan and Stephan, 1990). Collegial comparison is the process of engineers comparing themselves to other reference engineers or colleagues who they consider close enough in career development to be a relevant benchmark.

> Another way (to assess my competence) would be to compare myself with someone I went to university with, see where they are at now.

Such comparison may range from observations of where the other colleague is in terms of responsibility or the difficulty of projects undertaken, to observing the day-to-day skills of that colleague. The types of projects and responsibility given to an engineer are seen as reflections of how other people have assessed the competence of that engineer.

> In terms of assessing my own competence I guess my benchmark is up against your peers in terms of what you know other people are doing, what level are they operating at? I compare myself to them, that's the way I do it.

> I guess my competence is - it could be a number of different ways that I rank my own competence. I have got a job where I am responsible for (an asset), other people working in the same office as myself (are managing other assets) so one way that I would rank my own competence is to compare myself with their performance. We do a lot of similar work for those utilities such as asset manager, budgeting and reporting on our respective facilities - comparing myself to that.

Collegial comparison occurs when engineers have other pertinent colleagues to compare themselves to, such as colleagues who work in the same organisation. Some engineers may work in areas where they don't have any engineers they consider to be similar enough to compare themselves to.

> (To compare yourself to others engineers as a way of assessing your competence) you have got to be comparing yourself to somebody who occupies a very similar niche. I don't have that really particular niche to compare myself to. So I guess there are a few of them, but everybody does slightly different things, and what I do is completely different from hydrologists.

Typically engineers do not want to appear to be doing worse than a reference-engineer and so the presence of a reference engineer may encourage them to try harder not to give up on a difficult project.

> It is quite competitive within the office. There is one guy who is very cluey and he started the year after me. We are at about the same level of responsibility... ...There is some form, not so much - I don't think it is competition as such - but we are both aware of each other's jobs. And I mean if one or other is- as I said, can't do it - it would be not so much embarrassing but it was kind of like something that your mind would think, 'I just can't give up (just) because it is too hard'.

While collegial comparison tends to involve using colleagues who are at a similar age of experience, engineers tend to turn to more experienced colleagues when they are seeking reassurance.

6.4.6 Reassurance seeking

Reassurance seeking is the process by which engineers actively seek out information on the performance of their projects and/or their competence. It involves getting help in assessing competence, rather than just gaining information to help establish expectations.

> Sometimes I think, 'we'd better get this right, the consequences might be fatal!'. It's a big advantage that we have real experts (in my employment

> company). So we have this backup: have this ability to actually go to the expert to have them check your work, and they tell you, 'that's OK that's fine, it's going to work'. This is quite reassuring.

Reassurance seeking typically occurs when engineers are unsure about whether or not they are doing a good job. It can occur in conjunction with gaining advice from people, such as when seeking information to fit to the project.

> And I do tend to talk to other people quite a bit about what I am doing and try to get feedback, if I am working on something difficult, from other people.

Reassurance seeking is, in effect, about gaining information on others' perspectives of one's own competence (an actual/other self-representation) and the competence one ought to have (an ought/other self guide). While engineers may take on board others' perspectives of their competence (that is their actual-own image matches the actual-other image), this is not always the case as engineers sometimes question competence-implicating cues.

6.4.7 Questioning Competence-Implicating cues

In many cases engineers will accept competence-implicating cues as valid indications of their competence. However, in other cases while information may at first appear to engineers to be critiquing their competence they go on to question the pertinence of that information to their competence.

> But I think it is the soul destroying part of it, because ultimately you are working as hard as you can for the rate payer, they can be very vicious at times telling you that they, 'don't think you do a good job', but you are doing a good job.

Information may be discounted through the process of external attribution. For example, in the following quote it is implied that the engineers being discussed blamed others for the problems.

> Now one of the things that I found quite difficult with that was that these things are not very clear that its sort of one cause or another. In actual fact there were some technical issues that we should have actually handled here, but I found it was very difficult for some of the engineering staff to actually take ownership of those problems that occurred. And those were internal communication problems like the geotechnical engineers identifying some of the problems that were likely to occur but that was not being picked up by the (structural) engineer.

The extent to which engineers know the people who make the competence-implicating comments can influence the extent to which they accept that information

as valid. For example, an engineer who knows that someone typically gives negative feedback will be more likely to discount negative criticism from that person.

> Some people are just negative all the time and after some time you find out about that, and so it's not necessarily anything (to do) with your proposal, they are just negative because they always are, so you just ignore it for a start.

Engineers' desire for knowledge about their competence means they often deliberately seek competence-implicating cues, as implied in the strategies for assessing competence that have been discussed so far. The seeking of competence-implicating cues may continue after an engineer's involvement has officially ceased, and this is explicitly discussed in the following code.

6.4.8 Tuning in

Tuning in is the process of engineers retaining an interest in their projects as their formal involvement with the project decreases, or stops altogether. Engineers stay tuned into projects in part so that they gain information pertaining to their competence.

> The departure of Endeavour didn't signal any relief in the office workload. We had an enormous backlog. The urgency of Scott Base had swept aside other work. While we worked, our ears were tuned to catch any word of the ship's progress. With the help of an American icebreaker the little ship had finally broken clear of the pack ice and found itself in the calm waters of the sea between pack ice and the ice shelf. As soon as Endeavour arrived at the ice edge I waited with some trepidation to hear details of the proposed site for the base. Would it be on ice, perma frost or rock? ((Ponder, 1996, p.104), on his involvement with designing Scott Base).

The extent of tuning in can increase under situations of fear and uncertainty, for instance, when engineers think that their projects may have problems that may adversely implicate their competence or have negative affects on others.

> (As my involvement in a project comes to an end I have) a feeling that I wished I had more time to do a better job, a feeling of stress and (being) rushed and just trying to get the thing out, and also the feeling that the project needed something... ...but also concern that is there something wrong with it, (I've) made some errors in it.

The extent to which engineers tune in alters as the presence and nature of feedback indicates to them how their performance is being assessed.

> If I am not getting any feedback, then looking at my work, or for any reason, (I) start to become a little more confident with it. But if the work is turning into a problem, you start to worry about... ...(I could) really be in the lime-light.

The extent to which an engineer remains tuned into the project can depend on how early in the development of the project the engineer's main involvement ceases.

> I have often passed (a project) through (to) where it was going on and (I) just keep my eye on it and respond if I see there are issues coming up. But like I say, usually by the time a project is fully finished I have moved well onto other stuff... ...I quite like (handing a project over) and getting it off my desk, but - yes it is quite funny really - I guess my level of - I never feel it is fully over when I give it to somebody to do the work. Because you know it is always going out (in public) and things aren't quite up to spec or - so I guess my level of involvement tapers off rather than drops off, and so by the time it is all finished I have tapered down to nothing. But I never get that sort of satisfaction of going, 'the job is finished, my involvement is completely over'.

In summary, the strategies engineers use in assessing their competence include assessing the project's performance; performance attribution, where engineers decide what factors influenced their project's performance and their own performance; comparing performance to process expectations; establishing expectations; collegial comparison; reassurance seeking; questioning competence-implicating cues; and tuning in after the main project involvement. Both the engineer and other people develop views of the engineer's competence. Engineers can attempt to influence these perceptions held by other people, and this is described by the code 'influencing others' images of one's competence'.

6.5 Influencing others' images of one's competence

Engineers are concerned not only with how they perceive themselves, but also with how others perceive them. That is, engineers view their own competence in relation to their perceptions of what others think their competence is or ought to be. Influencing others' images of one's competence incorporates strategies for influencing both actual-other and ought-other images. Engineers may attempt to impress others by appearing very confident and knowledgeable in order to improve actual-other images.

> I can say to the contractor, 'so you've allowed about so many man-hours per square metre for that sort of stuff?' And I'm probably the only engineer they have spoken to from a client, or a designer type background: you know, 'he knows about that! How does he know about that? How does he know about our words and our language?'... ...they know that I know - you know - they know that I know, that I am not green.

Engineers can try to alter ought-other images by attempting to get others, such as clients, to have an understanding of the limitations of engineering work.

> Setting high standards: no matter how hard you try within this profession you can't get it right. The laymen, in the council particularly, don't seem to understand us. E.g.: 'it doesn't work as well as you said it would', so we have to say, 'no, it doesn't, so we'll have to change this and this etc'. You never, ever hear an engineer stand up and say, 'I guarantee this will fix the problem'. We say things like, 'this will reduce the seriousness or frequency of the problem'. Engineers are always trying to battle with nature and have a healthy respect for what it can do.

People more often present themselves as more competent in public than they do in private (Whitehead and Smith, 1986). Similarly, engineers sometimes attempt to create an unrealistic public-self, in which where they present themselves as more competent that they actually think they are. This situation can occur when engineers apply for new jobs, where they attempt to influence the way others assess their competence by reference to projects they have been involved with, where they may infer more responsibility in their involvement in projects than was actually the case.

> I guess, as I have got older I have been less concerned about trying to influence other people about my own competence and I would say deliberately... ...I think (this) is probably (due to) old age and maturity I guess. I think at an earlier stage in your career you tend to try to keep pushing yourself forward in front of people, you know you say 'listen, pick me, pick me'. So you are bouncing up in front of them and saying, 'I have done this, I have done that', or whatever. As a commentary it is quite interesting when we recruit people, by the time a young engineer is 28 they have done everything: designed from the London underground, to oil platforms off the Scottish coast, to an oil refinery in the Middle East. And so you say, 'hey, yeah, OK'. They are brash and young claiming all this responsibility... ...They are certainly putting across more experience than they can lay claim to.

Appearing to be more competent than is realistic can also occur at a company level when bidding for work: it may be inferred that certain highly competent people will be significantly involved in the project, when in reality that involvement will be minimal or non-existent. This is more likely to occur when there is intense competition in the market. Engineers soon learn that these behaviours are likely to get them into difficulty.

> When I worked for the organisation before I came here, it was always a bit of a joke that when we put a team together for a project (for tender bids) we were bull-shitting because we actually never had the people, the resources. But if they gave it to us we would do our best to do it... ...Now I've found increasingly, it might be a reflection of the market, but I think increasingly clients don't, well, come back to you.

Presenting realistic competence, that is, putting across a realistic impression of one's own competence (and possibly one's employer's competence) to other people, is considered important by many engineers. The importance of presenting realistic

competence is related to the importance of not working too much beyond one's competence, as described as part of engineers' common concern in Chapter Three. Indeed, the ability to present realistic competence is itself considered a facet of the competence frontier. For example, engineers can learn that giving others a realistic impression of ones competence is an important part of managing self.

> If you are not honest people pick you up on it and you fall on your face. You try and bullshit your way through things and then you realise that wasn't a good thing to do. I learnt to say very quickly that, 'I don't know'.

Presenting realistic competence can involve "fronting up" to admit incompetence should it arise. The honesty that is demonstrated in admitting incompetence can be important to maintaining positive relations.

> If you have that belief that you are going to act ethically with your client then you are not going to bullshit them. Often you get in situations where you get caught on the spot. And you promise things and, 'oh hell, now I've promised that how am I going to deliver?' And you do your very best to deliver, but if you can't deliver then you have to come clean.

The extent to which engineers' competence will be revealed to other people can influence the effort they put into presenting a competent image.

> Another thing I have found is dealing with the public and public perception of an issue, which has made a lot of projects difficult although they are not in any way technically difficult. Working for a district council, quite often projects can be made difficult by members of the public misunderstanding, or being concerned about the project you are working with... ...It also makes you do more work, sort've actually get in and make sure that your I's are dotted and your T's are crossed and everything checks out, you have got to start questioning things, make sure you have planned right.

In summary, influencing others' images of one's competence involves engineers attempting to influence the actual and ought images that other people have of them. While engineers can present themselves in an unrealistically positive way they tend to learn that this can have adverse consequences. Learning is an important component of engineers' reflection on their strategies for getting through projects, and this is presented by the code: reflective learning.

6.6 Reflective learning

Reflective learning is a strategy that tends to occur in conjunction with engineers assessing competence. It is the process whereby they reflect on a project and through that reflection learn about how they should or could get through another similar project, or alter their approach to the current project. Reflective learning is somewhat

different to gaining experience just through involvement in a project. This is because the learning involves deliberate and conscious reflection. The following quotes are typical of the questions engineers ask in reflective learning.

> You just try to learn from (projects)... ...you think, 'what did I do right and what did I do wrong, and what did those other fellows do right and what did they do wrong and if I did it again how would I do it differently?'.

> (What I reflect about) depends on the project, whether a good job has been done, whether the design is right, whether all the factors have been taken into consideration, whether my level of knowledge at that stage was as good as my level of knowledge now and would I end up with the same product? Is it actually heading in the right direction?... ...(I) just probably go back and question most of the steps involved, ahh, most of what I do at some stage or another.

Reflective learning is more likely to occur when projects have gone particularly badly, or particularly well. This may be in part due to there being more potential for learning from such projects.

> You learn a wider variety of skills with difficult projects. If all my (projects) were straight-forward and simple, and things I already knew about I wouldn't have learnt anything in the whole time I was here, apart from the first 3 months settling in. With challenging projects I learn more things. I learn how to deal with people, it's ongoing. You would get bored if everything was too easy.

> There are some (projects) that I do (reflect on), for example this asset management thing - although I won't be able to see it physically - so I'll definitely be reflecting on it in a strong fashion because it's sort of gone wrong and hasn't been done as well as it could (be). I mean that's always going to prick in the back of my mind as being the example of how not to do it. And probably for another job that we've got (which) is a design catastrophe it's going to be another thing that will stick in my mind as saying how not to do it.

Although reflection may occur, if engineers are not able to develop a satisfactory mental model of what influenced project performance they can be left in a state of uncertainty: they are not able to develop any proactive plans for how they should get through another similar project.

> I just happened to choose the right strategies and they worked so I learnt a lot from that, whereas another (project) I feel like I've learned nothing I just can't seem to get anywhere. I don't think I've learned much at all, or nothing that's successful.

The amount of reflection that engineers do can be significantly influenced by their fear of failure, although in the following quote to what extent this reflection is concerned with assessing competence rather than reflective learning is unclear.

> (The amount I reflect on projects has) definitely (changed) from my early days. In (my previous employer) I was very nervous, young, and I felt under confident around other people and (was) very unconfident with my - with the authority and responsibility I had. So I guess I'd do a lot of procrastinating and reflected a hell of a lot on what went on and been quite worried about it. These days I find that, well, I feel a lot more confident in what I do generally. So I feel that - I reflect a lot less than I used to because you know that confidence takes away a bit of the uncertainty, and uncertainty is a good reflection trigger anyway.

While some young engineers tend to start with a habit of reflective learning, usually in part due to fear of failure, other engineers tend to reflect more as they get older. This may be due to a process of learning to reflect, or because they gain more experience with which to compare and contrast different projects, and thus learn from that.

> Oh course you do (reflect more now than when you start out as an engineer), I mean you have got the experience and hindsight to look back at it. Oh when we were young, and you have got your shiny degree - but you haven't got a b****** clue about how stuff gets built and things get designed (so you don't reflect much then).

Reflective learning can be restricted by the busy flow of work: engineers can be so busy doing the work that they don't have time to reflect.

> I probably (don't reflect on what happened and why it happened and so on) during the periods where I am finishing it up, but (rather) after the project has finished. While I am finishing it up, I tend to be under pressure, in a mad rush, (until) after it is finished. And then I basically have time to reflect back and think about what I have done and whether I have used the right approach, what I would change next time if I was to do that job and what I wish I had known at the beginning when I started it.

Reflective learning normally results in engineers developing proactive plans about how they would get through a similar project, or altering the way they are tackling a current project. Reflective learning can incorporate learning through observation of others who are involved in projects in addition to the engineer's own involvement.

> You are quite often (tuned in to how the projects have gone after your involvement has stopped)... ...when I'm off duty driving around the city looking at work sites going, 'tut tut', that sort of stuff. It's not my job or anything but you just sort of in tune with the roading environment. And you're aware of when jobs are taking place so you are always reflecting back at things you've done in the past and how they might have been done perhaps differently and, 'oh that's the techniques that they have used, I should have used something different in the past'.

Assessing competence, influencing others' images of one's competence and reflective learning have been described in this chapter as the processes engineers use when they

position their competence frontiers. An outcome of these processes is that engineers may affirm or adjust the position of their competence frontiers.

6.7 Affirmation or adjustment of the competence frontier position

The affirmation or adjustment of an engineer's competence frontier position occurs when the engineer develops, adjusts or affirms an actual, ought or ideal image of an aspect of his or her competence. These affirmations and adjustments occur as a result of the processes of positioning the competence frontier. The research data suggest that engineers do not have a lucid view of all their competencies (see for example the discussion on competence uncertainty in Chapter Four). Affirmations and adjustments in the competence frontier position were indicated in the interviews in subtle ways such as the recognition of gains in experience noted in Chapter Five, or in the feelings engineers have about their abilities.

> There is a couple of those issues coming up at the moment where I have advocated a particular design, and when it has been out to discussions and had other technical analysis there have been a whole lot of other arguments that have come in that I haven't been particularly aware of, or astute with. So I probably feel that I haven't quite done that work as good as possible, as well as possible.

> They quite often don't let me get many situations where you are under stress - solely up to you, the decisions and stuff like that - so that's changing now. So that's probably a reflection of competence: that they can trust me more to make my own decisions.

> At the end of the project I came out with a confirmed ability to organise people... ...I was pretty green construction-wise in terms of actually achieving stuff on a (construction) site. I'm not as green as I was.

A lucid image of one's competence frontier is unlikely in part because engineers are consciously focused on the project itself, and the management of the competence frontier often occurs back stage, or more sub-consciously. For example, I interviewed an engineer who was unable to answer how he assessed his competence, yet data from his interview included many strategies for assessing competence. The following quote indicates that an interviewee found it useful to explicitly discuss issues (related to competence) in the interview even though she did not normally think consciously about them.

> Oh I have been interested (in this interview) because you have asked me about lots of things that I haven't thought about before, that is good.

The changing demands on engineers' competence are indicated by the concern engineers have for performed situational competence. That is, engineers are frequently being placed in new situations where they have to use new or different competencies. Because so many different competencies are important, each engineer's competence frontier is likely to have many facets. It is only those competencies that are highlighted by the current projects engineers are involved with, or from projects that have been of particular importance to them, that are likely to be clear in their self-perception. For example, in the following quote the interviewee reaffirms her sense of competence by occasionally reflecting on a project she was proud of.

> I loved that project while I was doing it, I loved it when we won it, and I still pull out the report every now and then and I say, 'I did this'. You know, it is one I am proud of.

Many of the processes used to affirm or alter engineers' perceptions of their competence frontiers also serve the purpose of improving engineers' frontier building efforts, that is, the processes help engineers to develop proactive plans.

6.8 Proactive plans

Proactive plans are a consequence of engineers asking; "have I done a good job?", "what went right and what went wrong?". They comprise ought self-guides for future behaviour that result from assessing competence or reflective learning. Proactive plans can involve a concern with the current project: whether the engineer needs to undertake further work on that project. It can also involve a concern with possible similar future projects, and how the engineer would tackle them.

Proactive plans may be made about any of the frontier building strategies (such as those discussed in Chapter Five). For example, engineers may make plans about how they will go about managing themselves, shaping projects or engaging in relationship enhancing communication. Proactive plans may be general concepts applicable to many other projects, or technological concepts applicable to only certain types of project. An example of a general concept is presented in the following quote where the engineer plans to improve managing herself by reducing the extent to which she is concerned with and criticises her work.

> I do tend to put blame on myself a bit too easily, but I think I have probably got to work towards achieving a balance between what I do at the moment, which is being a bit overly critical and being overly blasé.

Proactive plans can be enacted through relationship enhancing communication such as the sharing of learning.

> The project has made me more proactive, and it's something I try to drum into my staff as well, the need to get lots of data. (There) may seem no point getting the data, but collect it and make sure it's accurate.

I have now described the strategies and outcomes of the frontier positioning process. The process is important to engineers' abilities to get through projects well, to their experiential learning and to the intensity of their emotions that result from project involvement. Interviews indicate, however, that there are problems with the frontier positioning process and these will now be discussed.

6.9 Current problems with frontier positioning

There are many instances in the present study of engineers using external attribution in that they attribute poor performance of themselves or their projects to external factors. It appeared, however, that there was often a cultural assumption among the engineering community and engineering clients or the public that engineers should be able to control all the factors that influence project performance. This means that engineers often experienced considerable discrepancy between their actual-own image of their competence and ought-other (and also discrepancy between actual-other and ought-other[21]) images of their competence. Some engineers were more conscious of this discrepancy, while others tended just to feel incompetent because of this actual-own – ought-other dissonance. This is not to say that engineers should not try to control those factors that they only have partial control or influence over, but it should be recognised that complete control should not always be assumed.

It appears that some organisations do tend to recognise the extent of engineers' lack of control over project performance, in which case greater emphasis tends to be placed on the process followed rather than the project performance. An engineer working in such an organisation, however, may still have problems with actual-own

[21] That is, they were not meeting the level of competence expected by others.

– ought-other dissonance when others such as the public or clients do not recognise the engineer's limited control.

As they gain in experience engineers increasingly identify complex arrays of factors that influence project performance, rather than just accepting criticism or interpreting the poor performance of their projects as their own failures. This suggests that open discussion about the many factors that have influenced a project's performance could be useful to facilitating learning among project participants. Wrap-up discussions, where all those people who were involved in the project discuss the project for the purposes of reflective learning, did not appear to be a common practice for participants.

> (It) comes to the next job and (some engineers) go, 'how do you do this again, I've forgotten?'... ...They're not thinking about things they've done in the past and then learning to record what they've done to go and refer to.
>
> I think a lot of engineers just finish it and put it away and don't actually go through the thought process of, 'well, I could have done this better if I had (done) this or this'. It's, 'OK where is the next one'. A lot of engineering projects don't have a wrap-up discussion. This would be useful especially for the younger engineers to be aware of the reflection process.

I would hope that in most situations having wrap-up discussions would be better than the climate of social innuendo about incompetence suggested in some interviews. Wrap-up discussions of projects would, however, need to be undertaken sensitively because they could increase engineers' self awareness, which can make people overestimate the extent to which external events (such as competence implicating cues) are directed to them and also intensify emotional reactions (Baumeister, 1998, p.687). So such discussions could make engineers highly concerned with how competent they have been, which could increase anxiety and the associated risk of procrastination. An aim for these wrap-up discussions should be, instead, to reduce stress and anxiety through greater recognition of the many factors that can influence project performance, because these discussions could reduce actual-own to ought-other dissonance.

6.10 Conclusions

Frontier positioning is a social-psychological process where engineers reaffirm or adjust their self-concepts of how competent they are, as a result of their involvement

in projects. It is primarily reflective rather than anticipatory, and involves thinking about the cues that arise from being involved in projects that implicate one's competence. It involves developing a mental model of the factors that contributed to the performance of the project and one's own performance. The frontier positioning process is influenced in several ways by the input from other people. For example, people may express opinions about the performance of an engineer or the project (competence-implicating cues), influence the engineer's establishment of expectations or actually help the engineer to think about the factors that influence performance.

Engineers are concerned with what other people think of their competence, and they can attempt to present themselves as more competent than they actually are. This can create problems for engineers because they may then be given projects that they find very difficult, so they learn to be reasonably realistic about the presentation of their abilities to others.

Frontier positioning is a cognitive process that occurs in a social setting. In the current civil engineering context there appears to be room for encouraging greater openness and explicit discussion about the links between engineers' performance and project performance. This could result in more learning opportunities for engineers and result in less anxiety and frustration.

Frontier positioning serves engineers' dual concern for the self, and for the impacts of their projects on others because engineers reflectively learn about how they may improve their efforts at getting through projects. Frontier positioning may indicate potential consequences for engineers resulting from a positive or negative shift in their competence frontier position, and consequences for others who are influenced by the project's performance. These consequence-indicating cues are thought about in the process of connecting-project-and-frontier, the subject of the next chapter.

Chapter 7
Connecting-project-and-frontier: "taking ownership"

7.1 Introduction

In the previous two chapters I have explained how engineers build their competence frontiers by getting through their projects, and how they position their frontiers by assessing whether they have done a good job. The present chapter explains the processes that determine the extent to which engineers strive to use their competence to influence their projects. The degree to which engineers identify their competence frontiers with their projects is important to these processes, and so "connecting-project-and-frontier" is the phrase used to conceptualise these processes. Engineers' concepts of "taking ownership" of their projects incorporate both striving to influence their projects and personal identification with their projects. Thus the concept of "taking ownership" is the in vivo term for these processes.

Engineers' extent of project ownership can be influenced by their perceived connections between their projects and their competence frontiers, which develop through an anticipatory cognitive process of *consequence appraisal.* Engineers are concerned not only with the consequences of project involvement for their competence frontiers, but also with how their competence will influence their projects, and also for the consequences of their projects for others. Through consequence appraisal engineers think about the importance of these potential consequences and the extent to which they can control them.

Many people are involved in and influenced by projects and they attempt to influence the extent of ownership felt and taken by others. Engineers are involved in this social process of *negotiating ownership,* which influences both the extent to which they can influence their projects, and the extent to which they can claim credit for project performance. Thus the negotiating ownership process influences the consequence appraisal process, and the extent to which engineers strive to influence their projects.

The extent of engineers' project ownership influences the nature of their *project participation. Procrastination,* a lack of time, and the act of restraining one's participation so as to allow others to take ownership, limits the extent of that participation[22]. The extent of project ownership can be focused on those aspects of a project that interest or concern an engineer, thus focusing the engineer's participation on those aspects. This is described by the term *prioritising concern.* Engineers' perceptions of the consequences of their project involvement (for the self and for others) influences how concerned they are with *assuring competence*[23], and hence the extent to which they strive to ensure they are doing a good job.

The concept of project ownership, that is, taking ownership of a project, will now be discussed in relation to existing theory on job and work involvement.

7.2 Project ownership

The concept of taking ownership of a project refers to striving to influence the project and having a sense of personal responsibility for the project.

> (Taking ownership means to) run the extra mile. Really find out what a client wants for a job, and giving that and a bit more besides... (For example, an engineer) made an effort to make a report appeal to the client.
>
> We don't just work for the money (but) also for the sake of the job, 'there's something we have been given to do, we want to do it as well as we possibly can'... ...Taking ownership is worrying about all the things that haven't been thought about... ...(It is) being responsible for how it works. And it's a long-term responsibility. You want it to work for everyone who is involved with it into the future.
>
> (Taking ownership) means taking a personal responsibility. It's not a responsibility that ceases at five o'clock. It's almost as though you are doing it for yourself.

In terms of the competence frontier, striving to shape a project involves using one's competence frontier to influence project outcomes, while acceptance of personal responsibility involves acceptance that project involvement may influence one's competence frontier. Taking ownership varies in extent, such that even a low level of

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[22] The extent of participation in a project is the extent to which the engineer is involved in getting through the project (frontier building), and to an extent assessing whether a good job has been done (frontier positioning).

[23] As a result of their concern with assuring competence engineers reflect on whether they are doing a good job, as occurs in frontier positioning.

involvement in a project will involve some use of competence and implicit acceptance of responsibility and therefore reflects at least a low level of taking ownership.

The concept of project ownership has some similarity to concepts that are related to the psychological involvement of individuals in their work. These concepts are usually described as 'job involvement', 'work involvement' or 'work centrality'. Job involvement is usually defined as a cognitive belief state of psychological identification with one's job, or the extent to which one's self-esteem is affected by one's work performance (Brown and Leigh, 1996). Newton and Keenan (1983) argue that work involvement has two distinct but related dimensions: one involving a cognitive state of psychological-identification with work, and the other being the extent to which self-esteem is associated with work performance, suggesting that job involvement and work involvement are similar constructs. Paullay, Alliger, and Stone-Romero (1994) argue that work centrality is different to the concept of job involvement. Their view is that work centrality involves the importance that work in general plays in one's life, while job involvement is the "the degree to which one is cognitively preoccupied with, engaged in, and concerned with one's present job" (p.225).

Definitions of involvement encompass global (long duration) and specific (short duration, situation dependent) constructs. For example, Paullay et al. (1994) argue that job involvement consists of two dimensions; one relating to the specific tasks involved in one's role, the other relating to involvement in the job setting. Along similar lines Jans (1982) breaks psychological-identification into identification with the position or job, and identification with the career or specialisation of which the job is a part.

Engineers' extent of project ownership is influenced by the consequence appraisal process, whereby engineers' involvement in projects is connected to their self-identity and self-esteem (because their competence frontiers form part of their self-identity and self-esteem), and is therefore consistent with the self-esteem and psychological-

identification dimensions of job involvement. Project ownership is at the specific end of the job involvement spectrum, as it refers to engineers' relationships to their projects, rather than their jobs. In support of this project focus, Starling (1991) argues that committing oneself to a project is different to committing oneself to a large organisation, as project commitment contributes more to the building up of one's character and reputation.

It is well established in the literature that many conditions can influence the extent of people's job involvement, and many of these conditions are also likely to influence engineers' extent of project ownership. For example, engineers for whom work is an important part of their life (high work centrality) can consider any project they are involved in to be important to the self and so they tend to take a high level of ownership for all their projects.

> I have a pretty strong work ethic so I'm quite committed to whatever the project is.

An important influence on the extent of project ownership that emerged with the present study was engineers' perceptions of the current, and anticipated future, interrelationships between their competence frontiers and their projects. For example, the extent of responsibility held by engineers' influences their extent of project ownership.

> If I'm in charge of it lock stock and barrel then I will own it.

> I think probably I have got a lot more responsibility in some ways, or emotionally involved in my projects than I have been in the past, so I am part of the project, it is very much my project, I will be held responsible for it - I am responsible for it and whatever happens will reflect on me at the end of the project.

> To be project manager for a construction company, that's the ultimate, especially for young people and you have your own (project) that's yours. So everything that goes wrong or goes right you personally take credit from or you get pissed off with, or at least I did... ...I still am like that now. I own the b***** problems associated with the projects.

Similarly, the extent to which individual engineers can influence their projects, and the extent to which the performance of those projects reflect individual engineers' competence, can be important to the extent of ownership they take. In the following

quote, for example, the engineer sees himself as being able to have more influence over smaller projects, which affects his ownership.

> With a smaller project it is easier to have ownership because you are involved in all phases of the project, it's really your baby. It would be harder to take ownership in big projects where you only have a small part.

The importance of the relationship between engineers and their projects to ownership is also evident in the influences that the stages projects are at when individual engineers become involved or cease formal involvement have on ownership.

> (Ownership is influenced by) how early you are in(volved in the project) and how deep you are in. If you inherit it your ownership is diminished... ...Our most successful projects are where people take the ball early and keep it to the end of the game. The kudos would be shared and therefore diminished if (you were) taken off a job before it was finished.

The importance of the relationship between people and their projects, to ownership, was known by engineers in the present study, as reflected in their deliberate efforts to increase others' ownership by allowing them to be involved in the whole of projects rather than parts, or to have influence on projects[24].

The nature and perceptions of engineers' relationships with their projects can change during project involvement, hence the extent of project ownership can also change during project involvement. The formation and adjustment in the extent of project ownership occurs through the cognitive process of consequence appraisal and the concurrent social process of negotiating ownership.

7.3 Consequence appraisal

Consequence appraisal involves a "cognitive appraisal" process, which "can be most readily understood as the process of categorizing an encounter, and its various facets, with respect to its significance for well-being" (Lazarus and Folkman, 1984, p.31). Cognitive appraisal incorporates primary appraisal, which involves an individual asking, "am I in trouble or being benefited now or in the future, and in what way?", and secondary appraisal, which involves asking, "what if anything can be done about it?" (Lazarus and Folkman, 1984, p.31). Cognitive appraisal theory is about people thinking about what coping method to use, especially when faced with stressful

[24] As discussed in Section 7.4.1

situations. In the present study the theory was useful to understanding how engineers decide how much they should strive to use their competencies to influence their projects. For engineers, cognitive appraisal focuses on appraising the consequences of their projects and what can be done about those consequences, so I have described engineers' cognitive appraisal process as *consequence appraisal.*

The appraisal of consequences is important because it is the nature of civil engineering that mistakes do happen and projects do sometimes go very badly. At some stage in their careers engineers are likely to be involved in such occurrences, which may have significant implications for their competence frontiers or careers.

> I think what tends to happen is anybody that goes in cocksure and believes they can do it right every time, is really just waiting for the time that things go horribly wrong. And they will eventually, you make some monumental cockups from time to time.

It is by trying to foresee what will occur, through the consequence appraisal process, that engineers can attempt to gain greater control over their projects. In effect, by understanding the potential consequences of their projects they are better able to strive to influence, that is, to take ownership of, those projects.

> I think that's part of my job: trying to predict things as much as possible to make things easier.

> You have to try and foresee a lot of things that come back to haunt you.

Although engineers can strive to think about potential consequences through their own initiative, it is also cues they receive from getting through their projects tasks and assessing their competence which stimulate them to think about potential consequences as implied in the following quotes.

> One of the projects I've got to get a resource consent but I don't think it's actually going to get one and that's actually affecting the type of work I do on it. It's quite hard to put a lot of effort into something that you don't think is that viable.

> I had designed some of the (construction equipment), but (the bolts) hadn't been done up properly, and the technician came up to (me), and said, 'Hey I think you had better have a look at this!'. So (part of the equipment) was bending. But by the time I saw it we were at the maximum breakout force, so it was an awful moment standing there watching it.

There are three interrelated focuses of the consequence appraisal process. Engineers can be concerned with the potential consequences of project involvement for their competence frontiers, that is the *project-importance-to-one's-frontier.* They are also

concerned about the potential consequences of their projects for other people, organisations and the environment, that is the *project-seriousness-for-others.* Thus in contrast to the focus on the self, described by Lazarus and Folkman's cognitive appraisal theory, engineers are also concerned with the affects of their projects on others[25]. Engineers are concerned with the importance of their competence frontiers to their projects, and their associated ability to influence or control their projects, and this is described as appraising the *frontier-influence.*

7.3.1 Appraisal of the project-importance-to-one's-frontier

Appraisal of the project-importance-to-one's-frontier appears to be mainly concerned with whether one is in trouble or likely to be benefited, that is, primary appraisal. It involves engineers considering how difficult tasks will actually be for them and hence whether their frontiers will advance, whether the performance of their projects are likely to influence people's perceptions of their competence and the influence of project involvement on their careers. By perceiving the implications of project involvement for themselves engineers are able to decide how much effort they should put into their projects, or in the rare case where it is an option, if they should attempt to avoid involvement. Appraisal of the project-importance-to-one's-frontier is evident in the following quote from Ponder who assessed that his reputation was at risk and this is why he moves towards involvement in the project.

> My first reaction was that they were asking the impossible and that they had better rethink their time scale. With some misgiving, as my reputation was on the line, I agreed to have a good look at the problem and see if there was any way it could be solved in time (Ponder, 1996, p.97).

In the following quote the engineer is keen to be involved in a project because she anticipates that it could be helpful to her career.

> I was actually really happy to be involved in (that project) because it is one of the biggest projects (of this type), in the next decade definitely in New Zealand... ...so it is a good thing to have on your CV basically. If you can say you were involved in (this project) with a capital value of (a number of million dollars), it sounds good... ...that was really one of the main reasons I wanted to do it, you know, so as to have it on my CV.

Another knew he needed to take ownership to ensure he would get future work.

> Earlier, he had his own company where he says, 'if you don't take ownership you are out of work'. (Interview notes).

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[25] This reflects the dual concern discussed in Chapter Three.

The *project-importance-to-one's-frontier* varies in extent. For example, high project-importance-to-one's-frontier is evident in the following quote, where an engineer discusses his perspective on being given difficult projects.

> I'm inclined to smile and say, 'ooh, this is a good one'. Difficult to me means challenging, it's fun, exciting... ...Demanding projects push me to go out and find out more than I already know. It's adding to my experience and those are the projects that I enjoy most. It would be disappointing for me if I was only involved on projects that didn't push me in that way.

The more important the project is to the frontier the higher the ownership is likely to be.

> Challenging projects enhance ownership, it's not 'another one of these?!'.

Low project-importance-to-one's-frontier is consistent with the concern of "qualitative underload", which involves an employee being given work that is of too low level (Keenan and Newton, 1985, p.155). For example, engineers can appraise low project-importance-to-one's-frontier when they get projects that are not the type that they hope to specialise in. In the following quote, for example, the engineer is interested in high-rise structural design rather than the structural design of domestic houses.

> Domestic houses, every now and then, you know, every company gets a wee bit quiet and we don't usually do domestic houses... ...I was given a couple more and I find they are just routine and you get bored with them...

The more engineers prefer the type of job function they are involved in, the higher their job involvement (McKelvey and Sekaran, 1977) and their job satisfaction (Meir and Erez, 1981). These findings suggest that job involvement may be related to engineers' expectations about whether their type of job function will advance their competence frontiers in the ways they desire. This is consistent with engineers' extent of project ownership being influenced by their assessment of their project-importance to-one's-frontier.

McKelvey and Sekaran (1977) also found that, for engineers, job involvement is associated with perceived structural decentralisation of decision-making, which means a high level of autonomy. In terms of the present study, a high level of autonomy is consistent with a project's performance being highly indicative of an engineer's competence, suggesting that autonomy is associated with significant

project-importance-to-one's-frontier and hence the extent of taking ownership or job involvement.

Appraising the project-importance-to-one's-frontier involves thinking about the potential positive and negative consequences for one's competence frontier. So project-importance-to-one's-frontier varies in polarity, being negative or positive. With challenging projects the consequences for one's frontier may be very positive, or very adverse, depending on how well the project goes. The possibility of adverse consequences for engineers' helps to explain the extent of anxiety and fear of failure found in the present study[26]. The following interview note is a comparison of two projects, both of which could lose money. The engineer increased his ownership with the project that he had a lot of responsibility for, as his project-importance-to-one's-frontier was high, but he did not increase his ownership for the other project, which he perceived to be unimportant to his frontier.

> One (project) he had been involved in early and was responsible for the bid ('I bid it, I own it, I run it'), therefore he increased his ownership when it started to look like it would not meet the bid. Another project which he became involved in part way through (as a holding position for him until another project that the company had bid for started) was going to lose money ('the project was a dog') so he did not take high ownership. (Interview notes).

7.3.2 Appraisal of the project-seriousness-for-others

The extent to which engineers take ownership of their projects can be influenced by their assessments of the potential consequences of their projects for others. Appraisal of the project-seriousness-for-others involves primary appraisal in terms of assessing what the stakes are for others. An awareness of the potential seriousness of a project for others is an important part of civil engineering. This is reflected in the formal processes engineers use to appraise the implications of their projects for others, such as social or environmental impact assessments, and methods for systematically identifying hazards.

In addition to these formal processes, appraisal of the project-seriousness-for-others can also involve informal processes, where engineers think about the potential or

[26] Anxiety and fear of failure are discussed in Chapter Eight.

actual consequences of their projects. The extent of project-seriousness-for-others may range from the comparatively benign concern for the effects of overrunning one's budget on one's employer, to more serious potential consequences such as dam failure. The latter concern lies behind the attempts to get more experienced staff involved in the construction of the Opuha Dam, presented below. In effect the concern about dam failure drives Tony Pickford and Laurie Wesley's attempts to influence the project.

> Tony Pickford inquired re DHL site staff experience in the construction of a large dam... ...Tony Pickford suggested that an outside Engineer with dam experience such as Howard Justice could be beneficial if he was on site for a couple of weeks. ... ...Laurie Wesley commented that dam failures are generally caused by minor details that do not seem critical during construction. Opuha2

The more significant the project-seriousness-for-others, the more engineers are likely to increase their ownership. For example, due to the potential for a project, involving purchase of a system, to go wrong the following engineer wanted to be involved in, and to have an influence on the project.

> We bought a system for the council. At that stage a lot of local authorities bought (such systems), and it had gone incredibly wrong, millions of dollars down the tubes, so they wanted a working party of four people to deal with that... ...I wanted to have an influence on what we got, and made sure it was right.

One way of taking ownership of projects by striving to influence their consequences is to simulate construction techniques.

> The people involved in the project appreciate the consequences of what could go wrong and they test all these things in advance. 'You do practise simulating things before you actually go out and do them' as there can be huge costs if things go wrongly or slowly. (Interview note).

Through the appraisal of potential concerns engineers focus their endeavours to influence their projects on those project issues that concern them most at that time. For example, during my own work experience I was asked to work out the length of piles for a marina, assuming a set height above mean sea level. Based on my sailing experiences I felt that this height was too low and could cause problems particularly with high tides, so I spent half a day trying to find evidence that I could use to convince the project manager that the height should be increased, instead of getting on with the task I had been set. Thus ownership can be higher for some project issues than others, as described by the code "prioritising concern" in section 7.5.3.

Whether engineers increase or decrease their ownership when the project-seriousness-for-others is high, can depend on their expectations of being able to use their competence to influence the project. This is the third focus of consequence appraisals.

7.3.3 Appraisal of frontier-influence

The extent to which engineers take ownership of their projects can be influenced by their cognitive appraisals of their frontier-influence. That is engineers anticipate ways in which they can use their competence frontiers to influence their projects.

> Quite often my mind starts to race off **thinking of all the eventualities and what you have to do to this project to make it better** than you did it last time and all sorts of things like that. (Emphasis added).

These appraisals are consistent with Lazarus and Folkman's (1984) concept of secondary appraisal, discussed earlier[27], because they involve assessing what can be done and how much control one has over a project. Engineers' competence frontiers are important to their perceptions of what they can do about difficult situations that occur. So the position of an engineer's competence frontier and its applicability to the situation, that is, the engineer's experience relevancy[28], are important to the ability to do something about the situation. Perceptions of personal control over stressful situations are associated with people using problem-focused methods of coping (Compas and Orosan, 1993, p.223). This is consistent with engineers increasing their involvement in, and hence ownership of, projects, when they perceive that they are more likely to be able to use their competence to influence their projects. High frontier-influence involves a belief in high self-efficacy, which is recognised to influence how much effort people expend in their endeavours (Bandura, 1987, p.42). The engineer in the following quote took considerable ownership of the project because he was in a position to make many of the decisions.

> On the (project) I was it. I had to make a decision on how to buy something. I might make that decision wrongly, but it was mine to make...
> ...a lot of the decisions on the (project) I made myself.

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[27] From Section 7.3.1.

[28] Experience relevancy is a condition that is very important to the difficulty of projects, as discussed in Chapter Three.

In a different project, however, the same engineer perceived that he did not have much influence on the project. That is, he perceived that his competence had little influence on the project. He appeared to have less ownership of this project.

> In this (project) I'm not very well off because rather than saying to someone, 'I want to do it this way, it's within budget, I've investigated three other ways, I want to go to it, let's start tomorrow', I'm in the situation where I go round and round and round looking at the minuscule aspects of the issue before I get commitment to it.

In effect, when you can't have much influence over a project there is not a lot of point having much ownership, or as one engineer put it:

> If you can't affect it or control it then there's no point worrying about it.

Sharma and Sharma (1978a) found that job involvement for engineers is greater for higher job levels. They suggest that higher job involvement occurs with higher job levels because it gives engineers greater control, a chance to use their abilities, autonomy and challenge. That is, high job levels may be consistent with engineers perceiving a high ability to influence their projects, so Sharma and Sharma's (1987a) findings appear to be consistent with the present study's interpretation that the more that engineers believe they can influence their projects, the greater their project ownership.

While the more engineers believe that they can use their competence to influence their projects the more ownership they are likely to take, this is not always the case. For example, in the following quote the engineer discussed not being too involved in his work because he did have the resources to address any problems. In effect his ability to influence his projects meant that he tended to experience his work as benign rather than stressful, so although he did his work he did not feel a high sense of ownership.

> You don't need to be tied up in (your work)... ...(Even) when I first started (I avoided getting too involved in the work because) we had good teams that I enjoyed working with so it was quite easy to talk to them about problems and they were there to support me as well. I've got that body of knowledge there to help you out.

Engineers may also take on high ownership of their projects even if they are not certain about their ability to control or influence their projects effectively. This is

reflected in the following quote where the engineer discusses keeping going with projects even though that may involve failure.

> I couldn't think of any project where I was too scared to tackle it because I was scared I'd fail. Sometimes we have failed. Failed to convince the public, failed to convince the councils... ...We (engineers) do make mistakes and sometimes they're fairly high-profile mistakes, but we can keep going.

In addition to the competence frontier, other coping resources can influence engineers' expectations of their ability to cope with and influence their projects. Terry, et al. (1995) describe social support and the personal characteristics of self-esteem, (low) neuroticism, and generalised control beliefs as important coping resources that affect cognitive appraisals of situations. The present study has not investigated the personal characteristics of engineers in depth, however many other factors that influence engineers' abilities to do something about situations presented by project involvement were described in Chapter Three. For example the history of relations, the resources allocated to a project during the project setup, and social support are factors that influence engineers' assessments of their ability to cope with problems that arise.

7.3.4 Combined influence of the appraisals

The combined influence of engineers' appraisals of their concerns with project-importance-to-one's-frontier, the project-seriousness-for-others and the frontier-influence affect whether engineers increase or decrease their involvement in, and ownership of, their projects. For example, appraisal of one concern may encourage engineers to increase their ownership, while their appraisal of another concern may encourage them to also increase, or alternatively, decrease their ownership. I present some examples of how the different concerns can combine to influence the extent of ownership taken by engineers below.

As a result of engineers assessing their performance predominantly through the performance of their projects[29], assessments of significant project-importance-to-one's-frontier tend to be associated with their perceptions that their frontiers can significantly influence their projects (high frontier-influence). That is, the more an

[29] As discussed in Chapter Six.

engineer can influence a project, the more the project's performance can implicate the engineer's competence. There can, however, be situations where engineers do not perceive that they have much influence over a project (low frontier-influence), but other people are not aware of this and they believe that the poor project performance implicates the engineer, thus the engineer perceives high negative project-importance-to-one's-frontier. For example, there may be differences between the perceptions of an engineer and the public of the extent of the engineer's control over the project, as in the following quote. In this case the engineer does increase her ownership even though she doesn't perceive high frontier-influence.

> (The) uneducated public they would expect you to say that it was fool-proof, but quite often one can't control (all aspects of the project)... ...Quite often projects can be made difficult by members of the public misunderstanding or being concerned about the project you are working with... ...It makes you do more work, sort've actually get in and make sure that your I's are dotted and your T's are crossed and everything checks out, you have got to start questioning things, make sure you have planned right.

Significant consequences of a project for other people (high project-seriousness-for-others) can contribute to engineers' needs to defend their competence (which involves high project-influence-to-one's-frontier). In the following quote, for example, although the engineer's competence frontier advanced considerably through involvement with the project, stress associated with his need to defend his competence to the media meant that he had to leave the project. In effect, there can be complex interrelationships between engineers' appraisals of the project-importance-to-one's-frontier and the project-seriousness-for-others.

> That was probably the low point in my career (dealing with the project) every man and his dog wanted to ring me to complain about the (effects of the project). I'm doing my best to convince the politicians and the (client) that we need to spend this money. It was a very bad time. High exposure to the media, and you're always on the defensive... ...The (project) was going to burn me out, there was no way I could stay in that job for more than 3 or 4 years without just getting absolutely overwhelmed by it. We advertised for someone to help me with it, we groomed them into position and I'm no longer with that job. If anything goes wrong with that job you're under pressure... ...I said I'll give it my best crack for 4 or 5 years but then I'm going to move out of that position.

When projects do not go well there may be potential for negative consequences for engineers' competence frontiers (high negative project-importance-for-one's-frontier). Whether engineers increase or decrease their ownership in such cases is complex. Engineers' beliefs about their abilities to do something about their concerns

(their extent of frontier-influence) are important. For example, the following respondent tends to increase his ownership when faced with project problems because he believes he can do something about his concerns.

> I'm wise enough to know when I'm getting to the limit of my current knowledge or experience. I'm confident enough to seek out people who may have been there before.

There are many projects where engineers are not able to easily get out of being involved in projects so they do their work even though there may be negative implications for their competence frontiers. It can, however, be hard for them to remain motivated.

> It's harder to put effort into something that's going wrong than when it's going right.

> Probably the most important factor affecting ownership is the spirit that surrounds the project: the competence and commitment of the people involved... ...To have ownership you have got to enjoy it... ...Ownership is higher if the job is going well... ...If it's uphill all the way then it is a chore.

The importance of the enjoyment of the project suggests that ownership is influenced by how engineers actually feel at the time of their involvement in a project rather than just their expectations of future outcomes of project involvement (that develop through consequence appraisal). However, expectations and current feelings may be linked, as a project that is not going well currently may be associated with expectations that the project will not result in positive outcomes.

7.3.5 Conclusions

Consequence appraisal is a cognitive process of anticipating the consequences and outcomes of project involvement and the extent to which these can be controlled. It is consistent with Lazarus and Folkman's (1984) theory of cognitive appraisal, except that it incorporates concern for potential affects on others, in addition to the concern for one's own wellbeing, as consistent with engineers' dual concern. There are three concerns focused on by engineers' through their consequence appraisals: the project-importance-to-one's-frontier; the project-seriousness-for-others; and the frontier-influence on the project. The extent to which engineers become, and remain, involved in projects and the extent to which they feel a sense of ownership of their projects is influenced by their appraisals of these concerns. These consequence

appraisals can be influenced by the social process of negotiating ownership, which is the other process that influences the extent of ownership taken by engineers.

7.4 Negotiating ownership

Negotiating ownership is a social process in which the people involved in a project attempt to influence the extent to which others take ownership of it. This goes both ways as other people may attempt to influence an engineer's sense of ownership, or the engineer may try to influence the extent of ownership held by others. Negotiating ownership can occur through written or verbal communication of the expected responsibilities or performance of engineers, and through more subtle communication such as expressing ownership through one's extent of project participation.

It is in the interplay of people attempting to influence each others' ownership, and to participate in their projects at a level that reflects their own sense of ownership, that engineers' levels of ownership are negotiated. It is as if everyone knows that ownership in different aspects of a project is necessary, and yet definitions of formal responsibility are insufficient to adequately clarify who should take what ownership. Furthermore, projects may often be successful because people do contribute beyond the formal definitions of their roles with the project, as indicated by the following quote.

> If you antagonise people they will go back to the perceived boundaries of their job and say, 'well that's not my concern'. They'll retreat a bit and that's definitely not helpful.

The extent to which negotiating ownership occurs is contributed to by the failure of people to take ownership to the extent expected by others; therefore those others feel it is necessary to do something about that lack of ownership. Note that lack of ownership may be perceived in terms of not only how strongly the individual feels about the project (that is, their extent of ownership) but also the extent to which they can adequately fulfil that sense of ownership and the associated project requirements (that is, their extent of project participation).

The explicit communication behaviours involved in attempts at *increasing others' ownership* or *suppressing others' ownership,* and the implicit communication

behaviours of *expressing ownership through project participation* are discussed further below.

7.4.1 Increasing others' ownership

Engineers attempt to make other people increase their ownership of projects by raising concerns with those people, and advising how those concerns should be dealt with, whilst in some cases, explicitly abdicating any formal responsibility. Engineers sometimes also request confirmation that concerns are being adequately dealt with, as evident in the following quote.

> Doug Hood's letter states that the defective areas in Zones A and B, adjacent to the left abutment area, have been repaired. No mention is made of other possible defective areas and I assume that there is sufficient evidence (eg close on-site supervision, construction photographs, etc) available to satisfy you that all materials placed against the foundation and/or diversion culvert do not incorporate similar defects. Could you please confirm that this is the case. Opuha 4

In the following quote the engineer is trying to get the assistant project manager to appreciate the consequences and responsibility he was carrying, that is, to increase his ownership.

> (I was discussing what would happen with the assistant project manager). I was saying that I think this is a serious risk, but the (construction equipment) was already there by then, and that starts getting really expensive having (the construction equipment) sitting there, so 'well OK we are going to have to go and see what happens'. He could not face it he went away. I said, 'are you aware of the problems with this?' and he, ahh, just disappeared. He was back in the office hoping. I said, 'are you aware of the risk you are taking?', he said nothing.

Taking ownership of a project involves thinking about how others' work ties in with one's own work on the project. Thus peoples' ownership of a project can be aided by helping them to keep communicating.

> We have a team meeting for each project once a week, where everyone discusses what they are doing and what the problems are. This stops them being too introverted in their thinking.

Giving people positive feedback is a way that engineers can encourage other people involved in a project to increase their ownership. This may act to increase their appraisals of their project-importance-to-one's-frontier.

> If people think they are good at something they will take more ownership, therefore I like rewarding people, giving them positive comments about what they are good at.

Increasing others' ownership involves attempts to maintain the commitment of others to the project. Starling (1991) identified that project managers sustain commitment by taking care about where something is said so that commitments are public and the act of commitment can be clearly linked to the individual. In terms of the present study this suggests that project managers sustain commitment to their projects by trying to get the people working on the project to appraise high project-influence-to-one's-frontier.

Allowing people to have influence over a project is seen, by some engineers, as a very important way of increasing the ownership those people have over the project. For example engineers may try to ensure that their subordinates are allocated whole projects to work on rather than just parts of projects.

> There is a management aspect (to taking ownership. I like to) give people a whole project rather than parts... ...I have got to allow people to develop their own individuality.

> They have to feel a part of (a project to take ownership of it). That their contribution is valued and that suggestions made will be fairly evaluated.

Engineers may deliberately restrain their own extent of ownership so that someone else can benefit from taking more ownership of a project.

> Sometimes you have to let someone else do it, let someone else take responsibility, allow people to make mistakes (so they can) learn.

7.4.2 Suppression of ownership

When other people take on a high level of ownership this can reduce an engineer's extent of control of the project (it lowers the engineer's frontier-influence and hence project-importance-to-one's-frontier). The engineer may be reluctant to allow this: he or she would prefer to stay in control of the project, and may try to decrease the ownership expressed by others. In this next quote Ponder is concerned about the self-imposed ownership of Captain Kirkwood, which could, according to Ponder, threaten the success of the project. Ponder attempts, successfully, to get Captain Kirkwood to reduce his ownership.

> Without warning, Captain Kirkwood, the master of Endeavour, announced that he would take command of the building party when the expedition arrived in Antarctica. After all our hard work to ensure that the base would be constructed without a hitch, the prospect of a ship's captain controlling the work was a disaster I was not prepared to accept. Luckily I had allies,

> including people with influence like Sir Ernest Marsden, Dr RA Falla, the scientist concerned with Ross Dependency, and Bob Miller. I also had a 'direct line' to the Navy Board using another of my hats as architectural advisor to the armed services. After some awkward negotiations, thankfully, Captain Kirkwood agreed to forget his self imposed task and we could breathe freely again. (Ponder 1996, p.104)

In contrast, in this quote the engineer does, reluctantly, hand over some of the ownership to others.

> I said (to the client), 'look I can't be bothered, owning a point on this, if he wants to do and make all the adjustments then it's up to him, as long as it is cheaper', but of course in the long run it wasn't.

Subordinate engineers' project-importance-to-one's-frontier can be suppressed by their bosses not valuing their contributions, thus giving the subordinates the feeling that they cannot take ownership of the project.

> (When people have low ownership it can be a result of) engendering the wrong attitude from bosses, (for example) to, 'do what you are told'.

Similarly, subordinates may perceive negative project-importance-to-one's-frontier where errors are not accepted, so they will not take ownership that involves risk of errors.

> If people are petrified of making errors they are not going to challenge boundaries, hence they won't take ownership. (This is why it is) important to be approachable... ...People need to be able to share their weaknesses without feeling (that) they will be belittled.

The management structure of companies and expectations for engineers to follow company approaches can restrict the extent to which engineers can influence their projects, and hence how much ownership they take over those projects.

> Big company policy can undermine ownership by suppressing flair... ...(I like a) flat management structure so I'm not dictating to my staff how it has got to be done.

The formal definitions of an engineer's role can be changed resulting in an increase or decrease in the engineer's ownership and/or involvement.

> Occasionally someone above me may try to reduce or increase my involvement. There may be moves to change the roles a wee bit.

The suppression of ownership by others can be conceptualised as people limiting the influence of individuals over their projects, and hence limiting the advancement of those individuals' competence frontiers so that they perceive low project-importance-to-one's-frontier.

7.4.3 Expressing ownership through project participation

People can negotiate ownership by expressing the extent of their ownership through project participation, thus encouraging or enabling other people to alter their ownership. For example, if one person appears to be taking ownership then others may reduce their ownership.

> I guess the interesting thing is that when you get a major stuff-up in a project, everybody dives for cover. There is a feeling that, 'thank God somebody is sort of dealing with it now, yes we knew there was a problem, oh I always suspected there was a problem, but that is fine, you are dealing with it now, I can walk away from it and leave you to it'.

In effect, people perceive that the level an individual participates in a project is an indication of that individual's sense of ownership. For example, ownership may be expressed by an engineer by deciding to make a project decision, doing what she or he thinks is best rather than accepting the advice of other people.

> Often their advice is crap, 'no I don't think I am going to do that. That was a dumb idea, I am doing what I think I should do'. And it will either get you into trouble or it might work.

In projects involving a number of different organisations the formal responsibility of each organisation can be somewhat vague. In such cases engineers may attempt to claim minimal responsibility, particularly if there are financial disadvantages to accepting ownership.

> Consultant B blamed consultant A for all the problem that occurred on site, and so it was a three way circle, with the client in the middle saying, 'well I don't know who to believe'.

Similarly, in his study of construction crises Loosemore (1997) found that "at a time when collective responsibility, teamwork and mutual sensitivity were highly important, crises appeared to create conditions which made them less likely" (p.15). This occurs because during a crisis the competing interest groups each try to ensure that "the social structure which emerges redistributes resources in their favour" (Loosemore, 1997, p.17). Thus financial self-interest can come to dominate over concern for the project itself.

The level of checking of an engineer's work influences the sense of responsibility felt by the engineer: the better the quality and quantity of checking, the less engineers feel responsible. That is, there is an implicit sharing of responsibility. The more levels of

checking there are, the less ownership engineers are likely to feel because they are less worried about problems being missed.

> I have a very good technician. I come up with the sizes and the structure and I hand my calculations over to him. He'll pick out some short-comings or practical limitations, there's a good interchange there. It's a checking process really... ...I'm not frustrated by the building consent process. I have always thought it's good, because there are people in the councils who are our equals basically, they'll ask questions, they might not get it right - you may have covered the area they are querying - but it's another form of backup. We are not in isolation, we are working together with people all the time.

Problems can be created for engineers if they assume that there is more or better checking than actually occurs. This means that problems may not be picked up until later on. An entertaining example comes from my own work experience for my first project. I had designed the levels for pipes in a stormwater system and gave these to the word processor operator to type. I did not realise that I had to check the work of the operator. Soon enough I got a call from the site engineer asking why the pipes had been designed to flow uphill! The following quote provides another example. In this case the engineer had to engage in high involvement in order to sort out the problems, but I had the sense that she laid most of the blame on others.

> I do recall one or two panic stations when we had to rethink the levels on the ground - when the design wasn't quite buildable - or other little things happened. I think that's fairly typical but it also represented the fact that I was doing the job with reasonably little supervision. Although it was fairly logical and straight forward it could also have done with some more brains on it. Especially some checking procedures which never happened.

As presented earlier, if one person's ownership increases this indicates that other people can decrease their ownership. However, an increase in commitment to the project from some people *can* increase the ownership of others.

> Commitment by others around you enhances ownership.

Presumably if others are committed to the project this engineer is likely to anticipate better project outcomes, and the project is more enjoyable, so his sense of ownership is enhanced.

In summary, negotiating ownership is a social process of acting out one's sense of ownership and attempting to influence the ownership taken by others. It is influenced by engineers' perceptions of what is at stake, that is, consequence appraisal. Negotiating ownership can, in turn, alter the stakes and therefore the consequence

appraisal process. Connecting-project-and-frontier is therefore processed by consequence appraisal in conjunction with negotiating ownership.

7.5 Project Participation

The present study suggests that project performance can be enhanced when engineers have high project ownership. That is, when engineers are proactive about planning their projects, ensuring appropriate data is gathered in a timeframe that will be useful, attempt to foresee potential problems before they arise and generally doing whatever they can to help their projects to run smoothly. For example, engineers' heightened concerns with assuring competence that result from the consequence appraisal process, encourage them to put extra effort into checking that they have done a good job. Engineers' extent of project ownership will often be consistent with their actual level of participation in their projects.

> I'd work long hours because (I'd) want the project to be a success.

Saleh (1981) suggests, however, that the striving component of job involvement should refer to a person's intentions to participate, rather than their actual participation, because the actual participation can be influenced by situational variables other than beliefs or attitudes (p.22-23). For example, engineers can find that they have too much work on to allow them to participate in a project to the extent they wish to.

> 'What stops me fixing things I worry about?' – if I am too busy.

> Taking ownership may still be high even if (you are) not able to meet deadlines due to other circumstances. (Interview notes).

In the present study, it was not only situational variables that restricted engineers' abilities to influence their projects, but also their intentions to restrain their extent of project participation so as to allow others to benefit from taking ownership of the project[30], and their problems with procrastinating. As discussed earlier project ownership can involve engineers focusing on some issues more than others, thus they prioritise their participation to those issues that concern them.

[30] As discussed in Section 7.4.2.

Engineers can strive so hard to influence their projects that they become highly stressed, and so their project participation can be considered over-involvement. Over-involvement is concerning because it is predictive of occupational burnout and lowered job satisfaction (Koeske and Kelly, 1995). The strategy of working long hours that is prevalent in many engineering workplaces can impact on engineers' well-being, as discussed in Chapter Eight.

Assuring competence, procrastination and *prioritising concern* are discussed further below.

7.5.1 Assuring competence

The possibility of adverse consequences (of competence or incompetence for others or the self) can influence engineers' desires to assure themselves and others that they are competent. The extent of engineers' concern with assuring competence influences the extent to which they engage in frontier positioning. For example, in the following quote the engineer reflects a lot on projects where she is concerned about whether she has made mistakes or that there may be potential consequences for others.

> I think I reflect on most of (the projects that I am involved with), but ones I have had difficulty I reflect a lot more (on), but projects that have been very routine and I was very confident (with), I hardly think about them. But the more difficult ones, (I'm) going over them for the reason that I am trying to find if I have made any mistakes, so those ones, or anything that is important for whatever reason, whether it is political or a health reason, or something like that.

In effect, the stronger the project-importance-to-one's-frontier or project-seriousness-for-others, the more engineers are concerned with assuring competence and so they want to check the performance of their projects and themselves through frontier positioning.

7.5.2 Procrastination

Procrastination is an issue for many engineers I interviewed. Procrastination is usually due to either a lack of commitment or a fear of failure (Ferrari et al. 1995). Consistent with these causes of procrastination, the engineer in the following quote cites large boring projects, and projects that are too difficult for an individual, as causes of procrastination.

> Procrastination. Sometimes it does happen. Whether it's procrastination for difficult projects, or just projects that don't appeal, large boring jobs... ...Sometimes if a job is beyond them they will procrastinate, they will look like they are gathering their thoughts or gathering information, but they're not, they're stalling. You have to watch out for that. And if that's the case you need to sit down and talk it through, maybe put someone else on it.

Procrastination with large boring projects indicates low project-importance-to-one's-frontier resulting in low project ownership. Low project-importance-to-one's-frontier obviously leads to procrastination because the individual does not consider undertaking the work is highly important to his or her goals. Procrastination with difficult projects occurs as a result of anxiety, or a fear of failure, which can occur with high project-importance-to-one's-frontier. Procrastination due to fear of failure is counter-intuitive. A task done poorly by a procrastinator can be blamed on time limitations or laziness rather than inability, so the procrastination then serves as an ego defense function and it is a means of avoiding or escaping responsibility (Ferrari et al., 1995, p.28). That is, by procrastinating the individual is attempting to avoid self-diagnostic information about his or her ability. However, while the individual is scared of failure, their procrastination is actually likely to make failure more likely.

> Yeah, I do, quite often (have troubles with procrastination), not often but at times I will procrastinate about a difficult project because I don't want to face it, but rather do something that was easier to do.

Procrastination can be influenced by the personal trait of *state-orientation.* Kuhl (1992) describes state-orientation as "a temporary or chronic, situationally specific or global, inability to integrate and coordinate cognitive activities according to current self-chosen intention" (p.125). That is, cognitive desires don't lead to action. One cause of state-orientation is the premature internalisation of other's expectations that are in conflict with one's needs: prematurely considering suggestions and wishes of others as self-committing obligations (Kuhl, 1992, p.108, p.112).

State-orientation is associated both with perseverance and preoccupation with a task, (that is, high ownership), which can result in over-commitment, procrastination and volitility or distractability from the task (Kuhl, 1992). The trait of chronic state-orientation is similar to *socially prescribed perfectionism*, which is also associated with procrastination (Ferrari et al., 1995). High levels of commitment, and work-flow characterised by periods of procrastination and volatility are evident in the following

quotes from one engineer, indicating that the engineer may tend to have a state-orientation. Memories of my own work experience similarly include frequently shifting focus from one project to another, that is, a high level of volatility. Similar volatility was also mentioned by another engineer I interviewed, who described the experience as "running around like a headless chook".

> (With a project I) usually go through the stage of awareness of the need, divine inspiration, **brilliant and rapid work to get it all done, stalling due** to technical processes, budgetary constraints, political opposition, or other issues that I haven't thought of. Then comes **disillusionment because things aren't progressing as fast as I want**, then comes **accumulation and backlog** when I find we have got a lot of these projects in the same situation, and by which state I am usually **inspired to start something else**... ...I haven't had one project that has gone from need and divine inspiration to satisfaction and completion without going through the other peaks and troughs basically... ...Yeah, I do procrastinate and sometimes I will rifle through my in-tray and then rifle through it again and rifle through it again on different days thinking, 'yeah, I have got to do this, I have got to do that, I have got to do the other thing', so - and never do, well not never do, I take a while to. So I actually find my motivation to continue to start up again the little steps of the process is often lacking, whereas I have got tremendous motivation to start something new and I think I have got a really great idea, 'Woowl, right into it!'. (Emphasis added).

The present study did not investigate the extent of state orientation among engineers. However, it may be significant because engineers are often prescribed goals by others. While state orientation can result in work-flow difficulties for an individual, such individuals can also be very useful to decision teams as they tend to be better decision makers when complex and risky decisions are involved (Kuhl, 1992, p.123).

Atypical procrastination has similarities to a temporary, situation specific state orientation. It occurs in a person without a previous history of procrastinating. Usually a monumental task has been imposed on a person without appropriate guidelines or mechanisms for feedback to determine whether the behavioural steps are correct, so the person starts in the field by persevering on portions of the task he or she knows are possible to perform satisfactorily (Ferrari et al,. 1995, p 226). The following quote is an example of atypical procrastination; the engineer has not been a procrastinator before, but when she is faced with a difficult project, she finds she is procrastinating.

> But I am finding that some of the things I find quite hard I am putting aside and avoiding, which is really worrying me. It's something I've never wanted to do and it's quite easy to do. It's quite scary.

Engineers are usually working on more than one project and this gives them the opportunity to keep themselves busy, while procrastinating on the difficult projects.

> I find (I procrastinate) particularly if you are really busy and you have got something that you know is going to take you a little while to get into and isn't a simple problem to solve. And if you are already busy it is very, very easy to justify doing the straight-forward projects and keep busy. I mean you can be doing like ten hour days or something, but at the back of your mind you know that you are not putting as much priority on something that is really nasty, as you should do.

Procrastination can be beneficial to the project when the engineer delays making a decision and thus gains more information to enable a better decision as discussed in section 5.4.2. Procrastination that involves delaying making a decision reflects a common dilemma in civil engineering: while delaying making a decision can enable more information to be obtained, at some point the cost of gaining extra information is likely to outweigh the benefits. In addition, the timing of decisions can be important in potentially political projects.

> At other times if - when more people get involved and it becomes more complex and more political - we then think, 'oh shit why didn't we make a decision then?'. And I saw Bob Norman who is quite a memorable Commissioner of Works, he had a very good article about: it's really making that judgmental call that the cost of more investigations outweighs the possible savings one may make. He is probably quite right, and that is what it is all about, 'look we can go on, asking for more and more tests but is it really going to matter?', you just bump it up a pipe size, put it somewhere else, or you say, 'we don't need it'. So it is judgement.

The ability for an engineer to continue to procrastinate on a task is limited by deadlines and the presence of other people who are aware of the engineer's progress, or lack of it. Some engineers talk about working like mad to get their work done on time due to earlier procrastination.

> And the other source of my motivation is the deadline, and I work like crazy to reach a deadline, and when there is no deadline and stuff that can just be processed at normal times, I find that the motivation to start that stuff or keep that stuff ticking over, is a little bit lacking.

In summary, for engineers procrastination often occurs with high project-importance-to-one's-frontier, but due to fear of failure the engineer delays actually get on with the challenging parts of the work. Procrastination can also occur when the engineer has low project-importance-to-one's-frontier.

7.5.3 Prioritising concern

The process of taking ownership affects how engineers prioritise the various concerns they have about their projects. Prioritising concern is the act of engineers prioritising how concerned they are with a particular project or project issue at a given point in time, and thereby what method of coping will be used.

The problem for engineers is that they could be stressed about all projects all the time in terms of the projects' potential to implicate their competence, and the potential for adverse affects of their projects on others. Engineers, however, have resource constraints that limit their project ownership. For example they may be limited in terms of time or their personal capacity to be concerned. This means that rather than being fully concerned all the time they establish, through consequence appraisal, when and how much they should be concerned.

> The intellectual challenge in terms of the resource consents and what have you requires me elsewhere. If all we were doing was (one type of project) I'd have a look at the odd one, you know. I've determined I don't have the need to so I don't. I don't have to fill up my day with making more work... ...I would probably spend more thought about a project applying for a resource consent a year down the road than I would something that is actually being built.

Prioritising concern may occur not only at an individual level, but also at a group level where individuals are influenced by the concerns of other team members. In addition, focusing too much on one concern to the exclusion of other concerns can be damaging for the project. In reviewing the documentation from the Opuha Dam, it appears that the people involved became focused on their concerns about earthworks, to the exclusion of concerning themselves with the flooding risk. Anthony Boyle, who reviewed the documentation for the Canterbury Regional Council, also noted this focus on one concern, and describes it as a paradigm shift.

> At this point there appears to have been a paradigm shift with respect to Construction Management. Consideration with respect to the 375.35 T&T level and by-pass capacity are being overlooked as the focus appears to be on earthworks logistics alone. Opuha 3 (Boyle's notes on what was occurring).

This paradigm shift, with the lack of focus on flooding risk was central to the final collapse of the dam.

7.6 Conclusions

In addition to getting though their projects and assessing whether they have done a good job, engineers take ownership of their projects. The extent of ownership an engineer has for a project is the extent to which the engineer strives to influence the project and its outcomes, and the extent of personal connection the engineer feels towards the project. The process of taking ownership of a project is also described as connecting-project-and-frontier.

Connecting-project-and-frontier involves engineers appraising the consequences of project involvement. Engineers are concerned about the project-importance-for-one's-frontier, the project-seriousness-for-others, and the frontier-influence (the extent of control they have over their projects). As a result of thinking about these consequences, engineers increase or decrease their involvement in, and ownership of, their projects.

The social process of negotiating ownership also influences engineers' ownership of projects. The responsibilities of the people and organisations involved in a project can be unclear as many factors can contribute to the successes and failures of a project. Negotiating ownership involves people attempting to gain greater or lesser involvement in, and responsibility for, their projects, through explicit communication and by expressing their own ownership through project participation.

Engineers' ownership of their projects usually influences their extent of participation in those projects, and is therefore an indication of the extent to which they engage in frontier building, and frontier positioning. For example, high project ownership can positively influence project performance when it involves engineers striving to influence their projects, often irrespective of their formal responsibilities. This can involve engineers contributing in whatever way they can to a project rather than just doing a minimal job. Although ownership is usually commensurate with project participation, procrastination, deliberately restraining one's participation so as to allow others to take ownership and a lack of coping resources can restrict that participation.

Project ownership is similar to concepts of job involvement, however it emphasises the importance of cognitive appraisals of situations, such as the process of consequence appraisal, to the level of involvement. Many variables are important to explaining variance in job involvement (McKelvey and Sekaran 1977), and research is still investigating such variables, see for example (Aminabhavi and Dharanendriah, 1997; Newton and Keenan, 1983). Perhaps what is more important is understanding the manner in which job involvement is developed (Rabinowitz and Hall 1977). The present study suggests that short term, situation specific, levels of involvement are a result of cognitive appraisals and the social process of negotiating ownership.

Cognitive appraisals are important to the formation of emotion (Smith, 1993). Strong emotions were expressed by participants in the present study and these emotions can influence the processes involved in getting through difficult projects, as discussed in the following chapter.

Chapter 8
Linking the processes, including the effects of emotional involvement

8.1 Introduction

The previous three chapters have described the three concurrent processes involved in engineers managing their competence frontiers; frontier building (getting through the project), frontier positioning (have I done a good job?) and connecting-project-and-frontier (taking ownership). The present chapter summarises these three processes and presents a model of the main inter-relationships between them. Engineers' emotions and the ways that engineers manage their emotions are described. Inter-relationships between the three concurrent processes and emotional responses are complex, with emotions arising out of the processes, and in turn influencing the processes. The present chapter therefore presents a second and more complex model of inter-relationships between the three concurrent processes that incorporates emotion. The extent of inter-relationships between the three processes, and with engineers' emotions, emphasises the importance of all three processes to the ability of engineers to cope both practically and psychologically with involvement in difficult projects. This is further supported by description of the ways engineers manage their stress.

8.2 Summarising and linking the processes

A summary of the frontier building, frontier positioning and connecting-project-and-frontier process strategies and outcomes were presented in Figure 4.1, while Figure 4.2 presented a model of the inter-relationships between these processes. These figures were placed in Chapter Four so the reader could refer to them while reading Chapters Five to Seven. These figures are on page 96a and can be folded out to be viewed whilst reading the following discussion. Codes that occur in the figures are introduced in the text in italics.

The inter-relationships between the processes are complex. In part this is because engineers are concerned both for their frontiers and the effects of their projects on

others (that is, the dual concern which was discussed as part of the common concern in Chapter Three), and many of the coping strategies serve both concerns. That is, the ongoing resolution of these two concerns is closely intertwined. The emphasis in the present study has been on using social-psychological theory to help interpret the data, resulting in a theory that is structured with an emphasis on the social-psychological processes involved in engineers coping with difficult projects (such as frontier positioning and connecting-project-and-frontier).

Frontier building involves developing and using competencies that are important to getting through projects, and that are considered important to engineers. In doing this, engineers are involved in shaping the content and the process of their projects (*shaping the project*) by fitting ideas to particular projects and attempting to get the approval or thumbs up from pertinent people and organisations. Thumbs-upping, and to an extent fitting, involve interacting with other people. The nature of relations between individual engineers and other people are important to engineers' abilities to get through projects. Engineers in this study emphasised that they often (though not always), put effort into *relationship enhancing communication.* In getting through projects engineers are involved in managing their emotions *(managing one's emotions*), which can be important to maintaining motivation, coping with stress, and managing the tendency to procrastinate, all which are important to getting on with the job. Thus skills in managing one's emotions can be considered competencies that form part of engineers' competence frontiers.

Skills in assessing the performance of a project (which occurs in *assessing competence*) and the consequences of a project (which occurs in *consequence appraisal*), and *reflective learning* can be viewed as skills that are important to the competence of engineers. These skills could therefore be placed as processes of frontier building, but they have not because of their importance to the social-psychological processes of *frontier positioning* and *connecting-project-and-frontier.*

The development of relations, either positively or negatively (*relationship development*), and *gains in experience* were emphasised by engineers as important

outcomes of getting through projects. When engineers perceive that they have gained experience, this reflects their view that their competence frontiers have advanced. This perspective develops by engineers thinking about *competence implicating cues*, which arise out of the process of frontier building, in the process described as frontier positioning.

In frontier positioning, engineers evaluate their competence by assessing project performance and its correlation with their own performance, in order to see if their competence is advancing or if they are being incompetent. This cognitive processes is important because, while there can be many competence-implicating cues, there is often a lack of reliable, explicit feedback about engineers' competence. Perspectives of competence are formed within a social setting where other people's views on each engineer's competence can affect the engineer's own view. Engineers are concerned with other people's views of themselves and so they can attempt to *influence others' images of their competence*. By assessing their projects and their involvement with them projects engineers engage in reflective learning, which can contribute to the development of *proactive plans* to improve their frontier building efforts. The frontier positioning process results in *affirming or adjusting one's competence frontier position.*

Frontier building and frontier positioning result in cues that suggest potential consequences (*cues suggesting consequences*) for engineers and their projects or others affected by the projects. Connecting-project-and-frontier (taking ownership) involves engineers appraising these consequences in the process of *consequence appraisal*, which involves asking "am I in trouble or being benefited now or in the future, and in what way?" and "what if anything can be done about it?". Connecting-project-and-frontier also involves a social process of *negotiating ownership*, where people attempt to influence other people's sense of ownership and participation in the project. It can involve engineers demonstrating their own sense of ownership through their extent of project participation. Consequence appraisal and negotiating ownership contribute to engineers' cognitive models of the extent to which their projects can influence their frontiers (project-importance-to-one's-frontier), the

project-seriousness-for-others and the extent to which they can influence their projects (frontier-influence). Perceptions that there are potentially important consequences for the frontier, or for others, tend to be associated with high levels of concern for assuring the self and others that one is competent. This motivates engineers to reflect a lot on their projects, for example through assessing competence (see the "*concern with assuring competence*" linking "Connecting-project-and-frontier" and "Frontier positioning" in Figure 4.2). Engineers' conceptual models of potential consequences (that is, their *consequence appraisals* of project-importance-to-one's-frontier, project-seriousness-for-others and frontier-influence) can influence their *project ownership*, that is, how much they strive to influence their projects. The extent of project ownership is usually associated with the extent of participation in the project, that is, frontier building. It also influences frontier building by focusing engineers' attention on some concerns more than others.

8.3 Emotional involvement

In the previous section I discussed a model that summarises the linkages between the three processes of the competence frontier; frontier building, frontier positioning and connecting-project-and-frontier. The interactions between these processes support the proposition that all three processes are important to getting through difficult projects. The inter-relationships between the processes are further complicated by the influence of engineers' emotions. From the first interviews that I undertook for this study it was apparent that engineers were emotionally aligned with how well their projects were going. If a project was going well then the engineer would be happy. If the project was running badly then the engineer would become, at times, significantly stressed. In this section I discuss the ways in which emotions can feed back to influence processes that occur as part of frontier building, frontier positioning and connecting-project-and-frontier. Thus emotions can be modeled as an additional layer of interactions that occur between the three processes. These complex interrelationships further support the proposition that all three processes are important to coping with difficult projects.

First the formation of emotions that are associated with project involvement are explained. These emotional responses change during project involvement as engineers respond to changing situations and this is described as emotional flux. Then the main types of emotions experienced by engineers are presented.

8.3.1 The formation of emotion

Figure 8.1[31] models the formation and influences of emotion that can occur through involvement in a project. The formation of emotion is shown to arise from the components of cognitive appraisal (shown in the hexagon in Figure 8.1.), which arise from the frontier positioning and connecting-project-and-frontier processes, and are influenced by frontier building (as modeled at the top of Figure 8.1).

Lazarus and Folkman (1984) argue that emotion is the result of a person's cognitive construal of a situation (p.264). While it has been established that affective (emotional) reactions can occur without cognitive processes, they do play a major role in forming the emotional episode (Zajonc, 1998, p.697). In other words cognitive appraisals[32] underlie and are an integral feature of emotional states, with cognitive appraisals continuously mediating emotional reactions (Lazarus and Folkman, 1984).

Smith (1993) proposes components of cognitive appraisal that determine the specific emotions that arise, which include *motivational congruence* (including future expectations of congruence), *motivational relevance*, *accountability evaluation* and *perceived coping potential.* These components and their relationship to the theory of the competence frontier will now be discussed.

Motivational congruence is the extent to which the situation is consistent or inconsistent with what the person wants (Smith, 1993, p.244). Frontier positioning results in the affirmation or adjustment of the position of the competence frontier. It

[31] Figure 8.1 is on page 201a and can be folded out to view while reading the text.
[32] The theory of cognitive appraisal was important to interpreting data in the present study. The cognitive processes involved in frontier positioning (Chapter Six), and consequence appraisal (Chapter Seven) can be viewed as engineers' cognitive appraisals of situations presented by project involvement.

involves assessment of aspects of project performance and the development of expectations of performance. Comparison of the position of the competence frontier and the project performance to the expectations provides assessment of motivational congruence. For example, in the following quote the engineer compares her performance to her goals, and because of the discrepancy she feels annoyed.

> You do tend to set yourself a performance goal and I felt I really wasn't achieving that at all, you know it was taking me longer to do things and the process didn't seem to be as smooth as I had anticipated and so I was getting annoyed at myself.

Motivational relevance involves evaluating the extent to which the situation touches on issues the person cares about or has a stake in (Smith, 1993, p.244). Lazarus and Folkman, for example, emphasise the importance of the appraisal of the significance of the situation to wellbeing, to the process of cognitive appraisal (and hence to emotional experience):

> Attributions of causality are cold perceptions of cognitions; they are simply statements about how things work. They are relevant to emotions, but not equivalent to cognitive appraisal, which adds the dimension of the *significance of the attribution for the person's wellbeing*. (Italics in original), (Lazarus and Folkman, 1984, p.271).

Consequence appraisal (a strategy of connecting-project-and-frontier) incorporates an assessment of "what is at stake?"[33], hence it gives an assessment of the motivational relevance of the situation. Engineers may appraise their frontiers or other people, organisations or the environment as being at stake (that is, potentially affected by the performance of the project or frontier), which can then influence their emotions. For example, the stronger an engineer's appraisal of the project-importance-to-one's-frontier or the project-seriousness-for-others the more intense his or her emotional experience of being involved in the project is likely to be.

> ...if the work is turning into a problem, you start to worry about it. (I could) really be in the lime-light.

Accountability evaluation is about who or what is to receive the credit or the blame for the situation (Smith, 1993, p.245). Thus an engineer's attribution of the causes of performance (or lack thereof) of the self or the project, which occur in frontier

[33] Asking "what is at stake?" (Smith, 1993) was described as asking "am I in trouble or being benefited now or in the future, and in what way?" in Chapter Seven.

positioning, and engineers' perceptions of their responsibility, which occur in connecting-project-and-frontier, contribute to the accountability evaluation.

Perceived coping potential refers to the person's evaluation of their ability to act upon the situation or adjust psychologically to the situation (Smith, 1993, p.246-247). Thus perceived coping potential involves asking "what can I do about it?", which occurs in consequence appraisal, as described in Chapter Seven. The perceived coping potential depends on both the skills an engineer has for coping with difficult projects (that is, the frontier-influence), and the external resources the engineer expects to be able to access, as discussed in Chapter Seven. Engineers' expectations of what they can do about difficult situations, can also affect their expectations of motivational congruence. For example, this engineer is anxious about her ability to meet expectations, and this can be conceptualised as a fear of motivational incongruence, that is, that the situation may become inconsistent with what she wants.

> ...it is a fear of not being able to solve the problem and do what is expected of me, and basically do the project.

In summary, it is proposed that the skills engineers perceive themselves to have for coping with a difficult project, and the processes of frontier positioning and connecting-project-and-frontier, influence their emotions through assessments of the motivational relevance, motivational congruence, accountability and coping potential. I turn now to emphasizing the emotional flux experienced by engineers during their involvement in difficult projects.

8.3.2 Emotional Flux

Situations faced by engineers during their involvement in projects change frequently, changing engineers' cognitive appraisals and hence their emotions. The frequent altering of emotional involvement is described as "emotional flux" (Lazarus and Folkman, 1984). The following quote shows how an engineer's feelings towards projects change as the situations presented by project involvement change and so the engineer continues to re-appraise immediate and future consequences.

> (When we respond to tenders that time is) characterised by **enthusiasm, belief that you really want it**, that you are the only consultant that is able to do it. That enthusiasm goes into the bid process. When you start to put together a price, work on the methodology, then you are starting to go through **the 'Oh Hell' phase at that time** as well, because a lot of the

> resources that you need to do the work aren't going to be available to you. Its budget is not going to be enough to do the job justice, so you are going to have to go through a bit of a compromise in terms of what you are going to deliver. On being awarded the project **you go through another burst of enthusiasm**, you are going to conquer the world, it's marvellous. And that is **followed by disenchantment** when you suddenly realise that you (have) actually got to deliver now, and meet those timeframes that you have actually promised, with people, who were available at the time you prepared the bid and promised they would help you, who now tell you that they're not. (Emphasis added).

Assessments of motivational congruence (or incongruence) can tend to occur around the time that milestones are due and completed, and so these times of project involvement may be more emotional that other stages of project involvement.

> There is always the milestones in projects, like you know you sort of have a project, and often - there is a certain point where you know you are over the hard thinking bit and it is just sort of the processing side of it. And often once you get over that hard structure process it is, 'whew I have got there', and it is just doing the admin and the structuring and process side stuff - once you are over that hill, even though the project may be ongoing I suppose that is when most of the elation comes in, because you have done the tough bit from your perspective.

Emotional involvement with projects can extend after the project is finished. For example, feelings of satisfaction and a sense of ownership of a project can continue for engineers long after their involvement with the project has finished, particularly if they perceive that they had an important influence on the project.

> I get a real sense of satisfaction when I look at that plant, because I was instrumental in getting the thing up and running and solving a lot of problems.

> You walk away, there is something tangible. There are projects in (a city) that my kids will be able to take their kids to and say, 'your (grand)dad was in charge of that'. If (a project I have worked on is on TV) the children say, 'you were in charge of that weren't you dad?', and I say, 'yes'. They can see tangible things.

The dominant emotions discussed by engineers were anxiety or fear of failure, frustration, satisfaction and excitement or challenge, and these will now be presented.

8.3.3 Anxiety of fear of failure

Smith (1993) describes fear and anxiety as occurring when the situation is motivationally relevant (important to the person), motivationally incongruent (the situation is not as desired) and there is low or uncertain coping potential (p.250). Similarly, Strongman (1987) describes uncertainty as a basic aspect of anxiety, but distinguishes fear from anxiety in that the object of fear is 'real', 'external', 'known'

or objective', (p.114). The fear of failure, however, is likely to be essentially the same as anxiety in the civil engineering context, as fear of failure is anticipatory rather than real or known, and occurs due to competence uncertainty. The fear of failure was admitted to be an issue, or to have been an issue in the past, for many of the engineers I interviewed. This fear has to do with the fear of not being able to do the project or task to the standard expected by themselves and others.

> In the earlier stages we were definitely chucked in the deep end, basically that helps with your development. Now at that time it was very daunting, actually a bit nervous about, 'can you do it?', it is a bit scary.
>
> I'm not a perfectionist, but I'm on that side of the line. I do become anxious if I don't think I'm going to do a good job or deliver on time.

The extent of fear of failure experienced by engineers depends on their appraisals of what difficulties are likely to be encountered in project involvement, and their expectations of their ability to deal with those challenges. That is, it is mediated though the process of consequence appraisal. Previous experience and observation of the failures of others significantly affects engineers' appraisal of consequences and thereby their fear of failure. This previous experience may be from work experience, but can also be from an engineer's private life, or from being involved in other organisations. If an engineer observes that the consequences of failure tend to be less significant than he or she has anticipated, then that engineer is likely to become less fearful of failure in the future.

> Yeah, (I don't have as much fear of failure now as when I was younger) - I guess you learn - and reduced fear of failure is covered by the fact that I have made mistakes before and realised the consequences are never as bad as you think they are going to be.

If, on the other hand, some engineers observe that the consequences of failure tend to be worse than they anticipate, then their fear of failure may increase. The consequences of failure can also become more significant as engineers gain more responsibility, thus they become more emotionally involved in their projects.

> I think probably I have got a lot more responsibility in some ways, or emotionally involved in my projects than I have been in the past.

A significant source of fear of failure for engineers is that they are often responsible for, and their competence is assessed by, the performance of people or factors that they do not have complete control over. Thus engineers may evaluate that they will be held accountable for factors they cannot control. This may be one reason why

increased fear of failure occurs with increased responsibility. For example, in the following quote an engineer who admits to having a fear of failure describes his emotional involvement as increasing with more responsibility.

> There is a higher level of responsibility and you become responsible for other people's (mistakes) as well as your own... ...and you can have a problem with a project, which is not your fault, but you will end up dealing with it anyway... ...you still end up covered in the same mud that everybody else gets covered in. So you are drawn - with increasing responsibility you are drawn into the responsibility for other people, and things that you don't necessarily have any control over... ...I think the level of emotional involvement increases rather than decreases.

In some organisations, however, there may be considerable understanding of engineers' inability to control all the factors that influence project performance and this can reduce their fear of failure.

> I am not sure (if I have a fear of failure or fear of being seen to be incompetent). I am tempted to say, 'no (I don't)', because I am really well aware that people make mistakes and I know I have made them, and I am also quite aware that - well I think I am very fortunate actually in that I am in an area, that is really new to (my employer and the region). And because it is so new, it is open to have mistakes made in it. So if I try something and it doesn't work, I suppose I have got a fallback, which says, 'well look, I did all the research I could, I did everything as well as I could, but it was just not an area that was a goer'. And so I don't, I don't feel too badly that I make mistakes.

Engineers' fear of failure can be influenced by other people's expectations of them. If expectations are high engineers can fear that their performance will not meet these expectations. Engineers anticipate such situations to be motivationally incongruent, that is, inconsistent with what they want.

> The expectations at (my work) are higher so there is a different sort of stress, not the stress you will have an insoluble problem, but the stress that you will fail to perform, so that can be quite severe sometimes.

Similarly, the individual's personal goals can influence the fear of failure. If an engineer hopes to become a competent engineer rapidly then this can increase their fear of failure. In effect such engineers have a high ought-own self-state, that is high goals about the competence they believe they ought to have or achieve through project involvement, and so they perceive high project-important-to-one's-frontier.

Levels of anxiety may also be affected by their ability to avoid projects that they appraise as being likely to be difficult. In the following quote this engineer is fairly unusual in that he can avoid projects if he so desires.

> (I'm) not usually anxious at the beginning (of being involved in a project) because if I had feelings of anxiety, I'm in the fortunate position of not accepting the job. I am selective – regard myself as lucky. If I was working for a consultancy I'd be assigned to a job and that could lead to anxiety.

Feelings of anxiety or fear of failure also contribute to the stress felt by engineers and therefore to the extent that they need to engage in managing their emotions (see the link from "Anxiety or fear of failure" to "Managing one's emotions" in Figure 8.1). As discussed in Chapter Seven, the fear of failure influences engineers' desires for assuring competence, and so they are likely to reflect more extensively on their projects in attempts to assess their competence (see the links from "Anxiety or fear of failure" to "Assuring competence" to "Assessing competence" in Figure 8.1). Fear of failure can result in engineers' intentions to participate in their projects (project ownership) translating into procrastination instead of participation. This involves engineers reducing their efforts in, or delaying when they shape their projects (see the link from "Anxiety of fear of failure" to "Procrastination" to "Shaping the project" in Figure 8.1).

Fear of failure usually occurs where there are high though uncertain expectations of the engineer's ability to cope with the project. So although the engineer perceives the project as challenging, there is the potential to influence the project. Frustration, however, tends to occur where engineers perceive that there is little they can do to influence undesirable situations.

8.3.4 Frustration

Anger results from situations that are motivationally relevant, motivationally incongruent, and the person attributes causes of failure to external factors (Smith, 1993, p.250). That is, "anger arises when someone or something else is being blamed for a stressful situation, and it motivates the person to do something to remove the source of harm" (Smith, 1993, p.249). It was frustration rather than anger that engineers emphasised in the interviews in the present study. Smith (1993) does not discuss frustration, however, data from the present study suggests that it is equivalent to anger except that the person perceives that they have a limited ability to control or improve the situation.

Engineers often face situations where they have only partial control over the factors that influence project performance. For example, often many people contribute to the performance of the project, and the performance of these other people can influence the perceived and actual performance of the engineer. These situations can be characterised by high project-importance-to-one's-frontier and project-seriousness-for-others (motivationally relevant) but low frontier-influence (low coping potential). Because of engineers' concern for the performance of their projects they can become very frustrated when their projects are adversely affected by factors that they can't control.

> Normally, (as I approach a milestone I feel) frustration because it's not going to be met. From any perspective that you look at it. From the perspective of working for a contractor it was great knowing a job was coming in on time and you were making slightly above the fixed margin. That was a great feeling, whereas on some jobs even if they were coming in on time if they were losing money, they were bastards, you know, no matter what you did they were still going to lose money. That was hard to take.

Engineers can also become frustrated when they feel that their work is unjustly criticised.

> One thing that really bothers me is that if I come up with a design of a building, and the builder has got the ear of the client probably more than you have, and (the builder says) 'look what you have got here I could do it (better/cheaper)'. Everyone gets examples of that. Once the job is on paper, it's very easy to criticise, because someone has made a decision. Those things bother me, especially when we are conscientiously endeavouring to come up with the most cost effective, structurally effective and safe solution.

The project set-up can influence engineers' level of control and hence frustration. The project may be set up with specific processes to be followed, which can influence the nature of communication the engineer will have with other people involved in the project. In the following quote, for example, the engineer discusses the long communication chains that lead to undertaking work that they later found was not wanted.

> You couldn't go back to the client to discuss things because the contractor didn't want the engineers to talk to the ultimate client. We had to act in contractors best interest rather than the client's best interest. It served its functions but there were plenty of situations where we would normally have given advice to the client. The client kept wanting changes, and the client told the contractor who told us. There were feelings of huge frustration because you were unable to handle the job properly due to the contractural arrangements (that did not allow the engineer direct contact with the client).

> Also poor management by contractor in timing of items of work, they expected things immediately. It was also frustrating if our work wasn't actually used or we had to do rework.

In support of this engineer's dislike of long communication chains, Loosemore (1997) found that tight communication structures, where people were able to communicate directly without going through intermediaries were important to efficiently managing crises.

Insufficient communication between people who have been working on a project prior to an engineer's involvement can also be a significant source of factors that influence the project, but which are beyond the engineer's control, as discussed in the following quote.

> There's one job I'm working on right at the moment, which is a relatively frustrating job because I wasn't involved at the start so it was pretty much dumped on me to do. Then the person who was the project manager resigned, so we've got a new project manager. So you've basically got two people who are doing the job (having) come in fresh half way through. We had a meeting this afternoon where we were discussing the draft report that we'd presented to (the client). And it eventuated that what we'd given them wasn't actually quite what they'd wanted. Pretty silly, it makes us look pretty silly, which is quite frustrating. Highly, quite aggravating really, especially when you've got a lot of other work on that you've been pulled off to try and do this and then find you've been wasting your time essentially doing stuff that you didn't need to do. Quite irritating.

Frustration can be caused by lack of progress, termed by some respondents as "going round and round and round". This may be due to a lack of information or an inability to see how to tackle the problem. It can also occur if engineers are unable to get others to commit to decisions. This can be influenced by low autonomy or by the need to get approval from others. This type of situation again involves frustration as a result of motivational in-congruence combined with low coping resources. In support of the importance of autonomy, a study found that engineers deprived of the opportunity to make project decisions report more job tension (Ivanevich, 1979). In the following quote an engineer finds his lack of autonomy and his difficulty in getting his superior to commit to decisions frustrating.

> I have a site manager who I report to... ...and he's not a good decision maker. He doesn't like making decisions, he likes to have a lot of information. When I go to him with a proposal to do something he will generally knock it back because he wants every single base covered... ...I'm in the situation where I go round and round and round looking at the minuscule aspects of the issue before I get commitment to it. So that's a big

> change from (a different project described as) the little job, and it can be a frustrating thing.

Engineers can also become frustrated when they fail to get information from others, or when people or organisations do not remain committed to decisions that they have already made, again reflecting concern with factors that influence the project's performance but which are not within one's control.

> I find it hard when people don't come up with the deliverables: do you chase them up beforehand? How should you act professionally, but showing it's important? There was a problem where I felt we had something agreed and arranged and other people in the organisation say, 'that's not acceptable'. How do you make sure people are committing to what they are saying (on behalf of their organisation)?

The frequency and intensity of frustration expressed by engineers significantly affects the extent to which they have to manage their emotions (see the link from "Frustration" to "Managing one's emotions" in Figure 8.1). Recall that managing one's emotions can be considered a strategy of frontier building because the ability to handle stress is considered an important skill for engineers. In addition, in social settings there are subtle codes about what feelings are appropriate to show in what settings (Fineman, 1993), and accordingly engineers may try to suppress feelings of frustration when attempting to engage in relationship enhancing communication.

Fortunately engineering is not only about being anxious and frustrated, as there can also be times of intense satisfaction and excitement.

8.3.5 Satisfaction

Happiness is a general response to success, where the situation is relevant to issues the person cares about (motivationally relevant), and the situation is consistent with what the person wants (motivationally congruent) (Smith, 1993, p.253). In the present study engineers often expressed a very strong sense of satisfaction from being involved in a project, although this was not always the case for very frustrating projects or those projects that do not reach satisfactory outcomes.

The sense of satisfaction follows from the frontier positioning process where engineers' competence frontiers are reaffirmed or advanced (motivational congruence), and the engineers consider this to be important (motivational relevance). That is, they perceive their actual frontier to have moved in the direction of their ideal

frontier. Their satisfaction may be stronger when their frontier has advanced in an area that they are interested in, and when they perceive it to be important to their career. So satisfaction occurs when engineers receive comments about their competence that they appraise positively, such as when an engineer has got the thumbs up from someone, reached project milestone or completed the project.

> Hopefully (satisfaction) just builds through and everything gets completed and the contractor is reasonably happy, he does a good job. Then when it operates it functions well and continues to function well, meets all of its performance objectives. So by that stage - I mean if you felt confident enough and the client is confident you do a joint paper on it. It is the normal cycle and then you publish it and then it is there. It is something concrete and (you can) give your presentation at that conference, 'this is what we hoped it would do, and it is doing it', and it is very satisfying, you can answer questions about it.

> It's quite good when you can do it properly and it goes through council and gets approved. Especially when someone who specialises in it, and reviews it and says, 'yes what you have done is correct'.

An engineer's sense of satisfaction can be significantly influenced by how other people feel about how successful the project is. This can in part be due to the feelings of these people being interpreted as competence-implicating cues by engineers, but there also appears to be an element of pleasure just from being able to help others.

> When it comes to finishing the project if the project is running well and the client is delighted you get a real buzz. It's not about making money it's about satisfying the client and getting the buzz from the client that they are actually happy with what you are doing.

Engineers' perceive that they have high frontier-influence when they think they have the ability to influence outcomes in a positive way for other people. These situations can contribute significantly to engineers' feelings of satisfaction. That is, situations can be very motivationally relevant when they provide opportunity to help other people.

> In council work you do get to help people... ...it really feels good to think that we will be helping people, making their lives better. There's not a lot of jobs where you get to do that.

Engineers can gain some satisfaction from being involved in a project that went badly if they learnt from that experience. That is, their competence frontier has still advanced even though the project went badly. Such feelings are, however, likely to be dampened by the negative feelings of other people involved, and the consequences

for those people. For example, projects that have gone badly can result in directors becoming involved in battles over financial claims in the fallout from the project.

Satisfaction can be very intense when an engineer has been involved in a difficult or challenging project that, nevertheless, has been undertaken well.

> The client has peer review teams with a wide range of perspectives. It's hard to keep your individual client happy and then convince the peer review team. I came up with a scheme and every one was so happy, because it (solved two problems). (Engineer sounds elated).

Satisfaction is primarily reflective and tends to occur towards the end of a project so its influence on participation in the current project tends to be limited. Instead, the main influence of satisfaction appears to be the extent to which engineers retain perceptions of high levels of personal connection with their projects, after their formal involvement in their projects have ended, that is post project ownership (see the link from "satisfaction" to "Post project ownership" in Figure 8.1).

Many studies show a positive correlation between job involvement and job satisfaction (Rabinowitz and Hall, 1977). The direction of the correlation has been debated in the literature. Saleh (1981) consider job involvement to be an intervening variable and job satisfaction a dependent (output) variable. Rabinowitz and Hall (1977) however, argue that job involvement increases as a result of satisfying experiences, while Sharma and Sharma (1978b) state that involvement may increase with satisfaction, or vice versa. Porat (1979) infers that there is an indirect relationship between the two variables with organisational factors mediating between job involvement and job satisfaction.

The perspective taken in the present study is that job involvement (project ownership) arises from cognitive appraisal, which may include engineers' appraisal of organisational resources as they establish what they can do about the situations they face with difficult projects. Engineers' levels of project ownership can influence their intensity of satisfaction because projects in which they have had a high level of ownership tend to be appraised as having higher project-importance-to-one's-frontier. That is, satisfaction is a function of job involvement. However, having satisfying

experiences through high job involvement could then lead engineers to appraise future project involvement as likely to have positive benefits for their frontiers, suggesting a bi-directional influence between satisfaction and involvement. Indeed engineers in the present study said that the extent to which they enjoyed a project could significantly influence the extent to which they took ownership of those projects, as discussed in Chapter Seven.

In summary, the data from the present study suggests that satisfaction occurs with motivational congruence and motivational relevance, and is also influenced by the expressions of satisfaction from other people involved in the project. The emotion of satisfaction tends to be reflective. Feelings of challenge or excitement, in comparison, tend to be anticipatory.

8.3.6 Challenge and excitement

Challenge is an emotion that occurs in stressful situations that are motivationally relevant, and currently incongruent, yet the person believes that if they try hard enough they can improve the situation, so there is potential for success (Smith, 1993, p.250, 252). Thus feelings of challenge or excitement are likely to occur when the engineer has borderline competence[34]. For example, early on in difficult projects engineers can be uncertain about their ability to cope, but anticipate the potential for satisfaction and thus feel excited. In effect, excitement or challenge occurs when they anticipate that they may be able to advance their competence frontier significantly. Excitement was frequently implicitly evident in the interviews and at times was also explicitly mentioned.

> I also have feelings about - quite excited about getting into something new, wondering what it is like, wondering if it is going to be difficult and whether I am going to be able to do the work properly.

> Usually (I'm) quite excited (when I first become involved in a project). Something new has come along, obviously I like variety in my work so, the prospect of any thing new usually fills me with sort of excitement... ...So usually I'd say I'm quite excited and that would be, yeah, that's about it.

[34] Borderline competence is a property of the competence frontier discussed in Chapter Four.

Engineers can also be excited about being part of large physical projects. That is, work may be experienced as a source of engagement with joy in the busy flow of work (Hearn, 1993).

> It's a real buzz to see big machinery working dawn to dusk 7 days a week and knowing you are ahead of the eight ball. We are achieving better than the productivity we bid on, so we are making money, and are ahead of the program. And the buzz of seeing that happen, being part of that. Pretty exciting investigating technical things: large unusual machinery – awe-inspiring stuff. Perhaps we're all just boys at heart. You get a real buzz out of seeing things happen.

The sense of challenge tends to result in effortful optimism (Smith, 1993, p.250). This involves engineers having a high level of project ownership that translates into high levels of participation in their projects (see the links from "Excitement or challenge" to "participation" to "Shaping the project" in Figure 8.1).

> The more difficult engineering projects are the more interesting they are and the more fun they are to be honest. The more you look forward to going to work to progress it, the more you think about it at night.

In support of the importance of a sense of challenge, Thamhain and Wilemon (1988) found that professionally challenging and stimulating work was an important driver for enhancing engineers' project performance.

8.3.7 Conclusions

The model of the formation and influences of emotion presented in Figure 8.1 shows that emotion can provide further complex links between the three processes involved in managing the competence frontier than those shown in Figure 4.2. It can be concluded that emotions can have both positive and negative influences on how engineers cope with difficult projects. This centrality of emotion, to getting through projects, contrasts with the typical perspectives on the role of emotion.

Emotions are often viewed as disorganising, chaotic and interfering (Strongman, 1987, p.85), and are treated as inappropriate for organisational life, with rationality and emotionality considered as bipolar opposites of a dualism (Putman and Mumby, 1993). Leeper, however, argues that emotions function much of the time and he "regards emotions as an active force, involving motivation and perception, which organises, sustains and directs behaviour" (Strongman, 1987, p.85). This regulatory principle of emotion is also important to Frijda's theory on emotion (Strongman

1987). Similarly, Schwarz and Bohner (1996) argue that the presence of a certain emotion informs the individual about the nature of his or her psychological situation (p.120). Indeed many theories of emotion hold that emotions exist to signal when situations need to be responded to, or no longer need response and action (Schwarz and Bohner, 1996, p.121). For example, by paying attention to our emotions we can be more aware of the possibility that when our emotions are aroused it may be due to an important reason that may require further attention (Schwarz and Bohner, 1996).

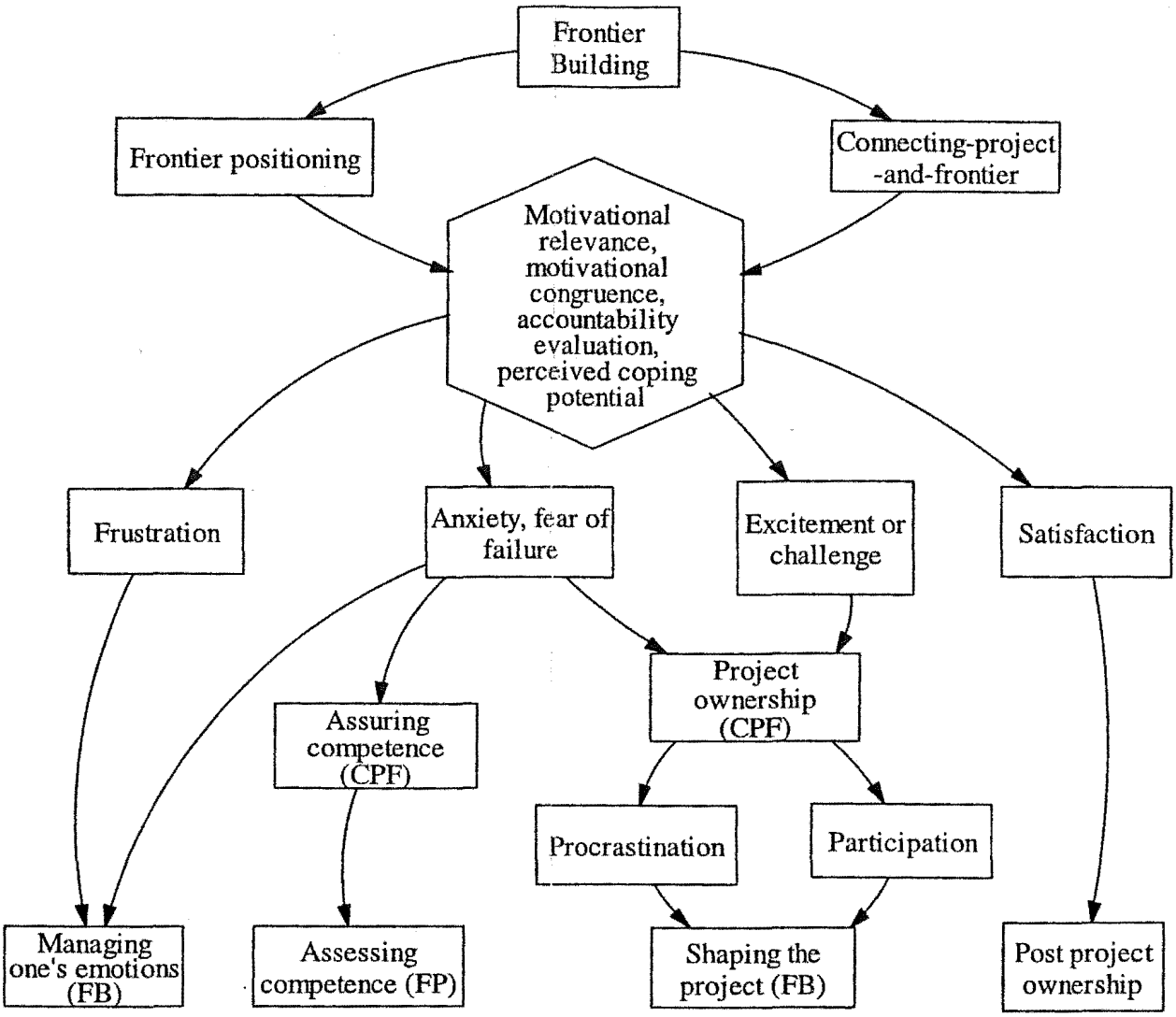
The importance of emotion in regulating our behaviour that is argued by these authors suggests that rather than just seeing emotion as something potentially disruptive to our effective working, which it certainly can be, we should attempt to understand how our emotions develop and influence our behaviour. Schwarz and Bohner (1996) argue that the influence of affective states (that is, emotions) on human action is likely to be highly complex, as the many links in Figure 8.1 suggest. The important point is that positive and negative emotions are an integral part of the experience of work, and those emotions play an important role in how individuals actually undertake their work. Our rationalisations affect our emotions, but our emotions also affect our rationalisations, or as Lazarus and Folkman (1984) put it, causality of emotion and cognition is bi-directional.

8.4 Stress management

The extent of frustration, anxiety and fear of failure experienced by engineers as a result of involvement in difficult projects contributes to their stress and hence their need to manage that stress. It was argued in Chapter Five that the ability to manage stress can be considered a facet of engineers' competence frontiers, as it is a competence that is important to the ability to get through difficult projects. Many of the ways engineers manage their stress involve them attempting to reduce it through frontier building, frontier positioning and connecting-project-and-frontier.

For much of the time engineers may just put up with emotional involvement, not attempting to reduce it, so they are *living their emotions*. Engineers can manage their emotional involvement in a problem-focused way by *doing a good job* or *having a*

Figure 8.1 The formation and influence of emotions



KEY

(FB) means a property of Frontier building

(FP) means a property of Frontier positioning

(CPF) means a property of Connecting-project-and-frontier

A → B A leads to or influences B

sort out, thus reducing the possibility of adverse affective outcomes. *Accessing support* is important to doing a good job, and can also contribute to engineers' emotion-focused coping repertoires. Emotion-focused coping can be particularly effective when engineers feel a high level of stress. In such cases the engineers may use one of a number of *chilling out* techniques. These properties of stress management will now be discussed.

Living the emotions involves engineers having emotions that arise from project involvement, but not doing anything to reduce them. That is, engineers may feel project-related emotions, yet do little to cope with or restrain them. This may occur if the emotions are not stressful enough for them to be motivated to take further coping measures. Some engineers may tend to live the emotions most of the time because either they have a lack of coping resources, or they are accustomed to being stressed and they put up with the psychological and physiological strains of being stressed. Coping attempts are initiated when the stress becomes sufficiently high.

> I need a fair bit of stress to keep me motivated. At times it's a little bit much and I've got to back off.

> How do you deal with emotions? I just have them really, don't others? I don't think there is any really particular dealing... ...But yeah, sometimes there is a bit of actually dealing with the (stress) factor.

External attribution, a process discussed in Chapter Six, is a cognitive process of deciding that factors external to one's control were the cause of a project going out-of-shape. In the present study it was found that external attribution could result in verbal abuse of others who are considered causal factors. While in some cases this may contribute to getting a project back into shape, it may also indicate that the engineer is unable to deal with his or her emotions in other ways. That is, verbally abusing others may indicate that the engineer lives his or her emotions. Establishing whether verbally abusing others reduces or further contributes to stress is beyond the scope of this study.

Emotions play an important role in directing and energising behaviour, as people attempt to reduce the negative impacts of stress by directing their coping towards the person or situation factors that cause the stress (Edwards, 1988, p.242-243).

Consistent with this theory, engineers in the present study, at times, focused their endeavours to influence those aspects of the project that were most concerning. This was described by the code "prioritising concern" in Chapter Seven, and is another link to the frontier building process. The problem-focused approach to dealing with the emotional involvement of projects is to attempt to *do a good job* through frontier building so that the emotional consequences of project involvement are more likely to be positive. This can involve putting in long hours.

> I guess I just get in and try and do the best job that I can do, I can't do anything better than that.
>
> I was there in the weekends making sure it would work. Just spent hours.

Indeed putting in long hours can be the way in which engineers are expected to deal with projects, an expectation that forms a part of the culture of many engineers' workplaces.

> He works 40 hours to rule type stuff and he gets a bit of hassle about that, where everyone else in the office tends to work, oh a few hours more.

Putting in long hours does not necessarily reduce engineers' emotional involvement however, as they have less time to spend away from their projects in which they can use chilling out techniques to reduce emotional involvement, and it can also contribute to tiredness.

> I have found a way of prioritising work life and home life and stress related things because in (another country) I worked very long hours with essentially no backup, stress can creep up on you before you know it. You work long hours and everything else deteriorates around it.

Because a high level of participation in a project will often involve working long hours, which can result in engineers becoming stressed, an arrow could be drawn on Figure 8.1 linking participation to managing one's emotions.

In addition to doing a good job engineers need to frequently *have a sort out* of their workflow to avoid or reduce overload. Note that this strategy is consistent with managing the tendency to procrastinate.

> If I'm too busy (I can end up) running round in circles... ...Then you have to have a bit of a sort out: delegate, make instant decisions, prioritise (which can involve) putting some things off, reprogramming, not do anything about it (that is) continue running around like a headless chook, or work more hours, which I prefer not to.

Having a sort out can also facilitate engineers' ability to chill out.

> (To help to cope with stress he) writes a list of job priorities on Friday so that he doesn't need to remember them over the weekend. (Interview notes).

When engineers manage their emotions by attempting to do a good job this often involves *accessing support.* Accessing support involves engineers discussing their projects with someone else, such as a supervisor, colleague or spouse. Accessing support can be useful to gaining knowledge for fitting expertise to projects, and it can help engineers to establish whether they are doing a good job (as occurs in frontier positioning).

> I do tend to talk to other people quite a bit about what I am doing and try to get feedback - if I am working on something difficult - from other people.

Engineers' opportunities for accessing support can be limited, thus making it harder for them to cope emotionally. This is consistent with the importance of the support situation to project difficulty mentioned in Chapter Three. In the following quote the engineer discusses his problem in sharing the project difficulties with other staff, and has to turn to other colleagues.

> It is interesting because in fact you can't really share things. After a while it just appears like you are just bitching and moaning, 'oh it can't be as bad as you say, you know, you could have done something'... ...I think emotionally it is one of the most lonely jobs, when you are having to deal with a difficult project. And it really comes down to the fact that you can't really go to your management. In some cases you feel that perhaps it is something that you should be dealing with anyway, so why do you need to go to your management, 'what the hell have you been employed for?' You can't go to some of your staff because again in some cases they were involved in the work and they have already distanced themselves from it. And I found the most important technique here was actually going to trusted colleagues and discussing issues and (asking) how would they deal with them in a similar sort of situation, so the old networking.

Spouses of engineers were often described as people important to engineers being able to cope with stress as discussed in Chapter Three. Secrecy and confidentiality were raised as issues that can restrict engineers' ability to discuss issues with spouses. It appears that this may become more of a problem as more women become engineers and the number of couples where both individuals are engineers (who may work in competing organisations) increases.

Chilling out is a range of emotion-focused coping methods that engineers use to reduce stress. These techniques use cognitive and/or behavioural changes to reduce

the sense of emotional involvement they feel with their projects. Chilling out is equivalent to the term 'psychological withdrawal'

> Psychological withdrawal is a form of affective isolation and distress avoidance through emotional detachment from a source of stress. Psychological withdrawal is not surrender. Developing emotional detachment does not preclude continued active involvement in the tasks from which one has withdrawn. In fact, a degree of psychological withdrawal may be essential in some jobs. (Quick, Quick, Nelson and Hurrel, 1997, p.214).

One way of chilling out is *role switching,* where work is left at work, which can include engineers having a symbolic change in their role when they get home.

> I try not to take work home, like when I get home I take off my work clothes - and everyone knows, kids might talk to me, the dog may come and say hello - I'm no longer the (engineer), I'm Dad and husband. So I tend to use that shrugging off transition.

A few engineers mentioned exercise as a technique used for reducing stress. Various psychological and physiological mechanisms by which physical exercise contributes to the management of stress have been proposed. These include, for example, the dissipation of hormones, glucose and lipids that are released under stress, the production of endorphins that produce a calm and happy state, and the mental diversion (that is, chilling out) provided by exercise (Sutherland and Cooper, 1990).

Engineers can chill out by *putting work in a broader life perspective,* as this reduces the emotional power and impact of the event (Quick et al., 1997, p.213). For example, engineers may decide that they are putting too much emphasis on work and that the associated stress is not worthwhile. It appears that these engineers decide that their competence frontiers need to be considered less important to their self-worth.

> I have had to do a bit of reading on some sort of wider aspects of life to regain a bit of sense of balance. I was letting the work pressures get to me a bit I think. Feeling stressed is the simplest way of describing it: just feeling it is fairly tough going. But I have got a much more relaxed attitude and I find that I can turn off at the weekends and get out and walk and do something else and come back feeling very refreshed and ready to go.

Similarly, engineers can *put consequences into perspective,* which involves them judging the significance of possible adverse consequences realistically. Some engineers learn through their mistakes, and observation of others' mistakes that the consequences are not as bad as they tended to fear earlier in their career. This results in them demoting, or being more realistic about, the significance of possible

consequences in later projects. In other words they learn to better evaluate the project-importance-to-one's-frontier and the project-seriousness-for-others.

> I think you do worry a lot more when you are younger, at least I did. But as you go through the mill and survive a few situations - both private and socially in sporting clubs and a few committees, you have scraps and things like that - so it all goes to this experience factor that you learn that if something goes wrong it won't be the end of the world, and you also see other engineers that have been through tricky situations.
>
> If it's the worst thing that has happened today it is still a success (because it's not like anyone was killed).

Another way of chilling out by putting things in perspective is *to accept that one is human*, which involves engineers accepting that they do make mistakes, that they are not perfect, that they are human. Accepting that one is human involves engineers accepting their frontier positions, forcing acceptance of the actual self as opposed to the ideal self.

> Sometimes I do feel particularly stressed. OK, that I have got a whole lot of work on, that I am not going to achieve very well. And that requires a serious stepping back and saying, 'what the ... and deep breathing, and saying, 'look I can only work seven and a half hours a day, and I do take work home because I enjoy it'... ...Yeah that is really a matter of just coming back to the fact that I am human: I do what I can, do better than most, probably not as well as some, and just, God, deal with it basically, live with the fact that you are human.

Talking with others is an effective means of emotional expression that is associated with reduced stress (Quick et al., 1997, p.245). Putting consequences into perspective often occurs in social settings, where other people help the engineer to see that the project difficulties are not too bad.

> But again I think that's part of my job... ...give people a warm cosy feeling wherever possible - that things might be bad but they could be worse (laughter).

Talking with others can involve *engaging in camaraderie*, which can, in itself, be a stress release.

> He deals with stress with physical exercise, or at work by having a beer after work. That might be part of a planning discussion and that will generally lead to a bit of camaraderie, which is bit of a stress release. (Interview notes).
>
> We used to verbally beat up on the applicant and the city and the consultant doing the plan change, 'boy they are stupid and why are they doing this, and this', like that. It was basically release of tension – but not at them personally - and the (client) most of all because they created the whole thing.

Chilling out can involve *letting go,* which involves reducing emotional alignment with project or events that have already happened.

> Think, 'could I have done things better?', and if you could do that next time, but yeah, move on.

The ability to cope with the emotional demands of work is important to engineers' ability to deal with difficult projects. In this section some of the techniques engineers use to manage their stress and their need to get on with the job have been discussed. Many of these techniques can be viewed as engineers altering the processes of frontier building, frontier positioning and connecting-project-and-frontier out of which the emotions that contribute to stress arise.

8.5 Conclusions

In conclusion, the complex interactions between the processes involved in getting through difficult projects emphasise the importance of all three. The present study proposes that emotion is central to engineers' coping with difficult projects, with complex influences between cognitive processes, specific emotions and the extent to which engineers actively engage in getting through their projects. Thus emotion can play an important role in accounting for variation in engineers' coping. There was considerable evidence in the present study that many engineers were not, or in the past had not, coped particularly well with their involvement in difficult projects. For example, the extent of feelings of frustration and anxiety can be taken as an indication of the extent of poor coping. In addition, many engineers mentioned that they had problems procrastinating, and this can be an indication of poor coping, even if it is temporary. While emotions can contribute to the distress of engineers, they can also contribute to engineers' motivation to get through projects. That is, it is valuable to conceptualise coping in terms of the development of stress that can spur organisational productivity and innovation (such as excitement or challenge), in addition to coping with situations that are perceived as threatening or harmful (Latack and Havlonic, 1992, p.483).

Chapter 9
Conclusions and implications

9.1 Introduction

The preceding chapters have presented and supported the theory, developed in the present study, of the role of engineers' competence frontiers in coping with difficult projects. In the present chapter, the theory is summarised and the main contributions that this theory makes to existing substantive literature are discussed. Implications for engineering practice arising from the study are presented and potential focuses for future research that have been indicated by the study are outlined. A personal reflection concludes the thesis.

9.2 Summary of the grounded theory

This study began with a focus on how civil engineers deal with ill-defined projects, however, soon after interviews began it became apparent that engineers are concerned with difficult projects that may or may not be ill-defined. Identifying the common underlying concern with difficult projects required an increase in my theoretical sensitivity through learning social-psychological theory, and a preparedness to ask engineers about their feelings arising from involvement in projects.

The common concern regarding difficult projects involves concern with the potential for such projects to affect engineers' competence, or perceptions of their competence. This does not just mean technical ability, but rather any sort of competence demanded by the situations presented by project involvement. Engineers frequently work at the edges of their abilities, which can enhance their competence. There is, however, increased risk of being incompetent when working at the edges of one's competence, and there is a social expectation that engineers should not work beyond their current competence. This means that engineers often feel anxious or have a fear of failure when they are involved in challenging projects. Engineers are concerned not only with how competence or incompetence will affect them and their careers, but also with the potential impacts on other people, organisations or environments affected by their projects. Perceptions of engineers' competence tend to be based on the

performance of their projects. Engineers do not normally have control over all the factors that can affect project performance, however, and they feel very frustrated when other people think they are not competent when a project does not perform well.

In effect, engineers each have a *competence frontier*, which is their self-image of their extent of competence. Engineers' competence frontiers are important to them: their frontiers form part of their self-esteem and they like to see their frontiers advance. Engineers can be uncertain of how competent they are, particularly when working with borderline competence, so they tune into any cues that implicate their competence. Engineers are strongly motivated by the ability to use their competence to have positive influences over the outcomes of their projects.

There are three concurrent, inter-related processes pertaining to the competence frontier that occur as engineers get through difficult projects. These processes will be briefly summarised here (see Chapter Eight for a fuller summary). One process, *frontier building*, involves engineers attempting to advance their frontiers through project involvement. In other words, by "*getting through the project*" engineers fulfill their roles within their jobs, and they may also gain in competence. There are many competencies important to engineers' ability to get through projects. The present study conceptualised engineers' work as shaping the content and process of their projects, by fitting expertise to their projects and attempting to get the thumbs up from relevant people and organisations. Other competencies focused on in the present study were the ways engineers manage themselves by getting on with the job (such as not procrastinating) and coping with stress, and the ways they engage in relationship enhancing communication.

Engineers think about competence implicating cues that arise from the process of getting through projects, in a process described as *frontier positioning*, or "*have I done a good job?*". Frontier positioning involves developing a mental model of the factors that influence project performance and their own performance. If engineers think project involvement has improved their competence they, in effect, perceive

that their competence frontiers have advanced. In the process of assessing whether they have done a good job engineers learn about how to improve their performance and the performance of their projects, and so this process feeds back to the frontier building process. An important way for engineers to cope with projects that perform poorly is to recognise that factors outside their control contributed to poor performance.

Engineers' conceptual models of the factors that influence performance are important to the third process: *connecting-project-and-frontier*, or "*taking ownership*". Engineers anticipate the ways that project involvement may influence their competence frontiers, and indeed how their competence may influence their projects. When engineers anticipate that there may be adverse consequences from a project, they put extra effort into checking that they do a good job. Thus the taking ownership process can influence the frontier positioning process. The extent to which engineers believe that their competence frontiers are important to their projects, and vice versa, contribute to the extent to which they strive to influence their projects. Engineers strive to influence their projects through the frontier building and frontier positioning processes. Engineers are not always able to participate in their projects as much as they wish to however, due to factors such as constraints on their time or the fairly common problem of procrastinating.

Intense emotions of satisfaction, excitement, frustration and anxiety often result from the "getting through the project", "have I done a good job?" and "taking ownership" processes, and in turn these emotions can affect the coping processes in a complex web of interrelationships. The interrelationships between the processes (including those which occur through the influence of emotion) reinforce the importance of all three processes to engineers' ability to cope with difficult projects.

9.3 Contributions to substantive theory

The present study is the first interpretive study to focus on the relationships between engineers and their projects and to provide an understanding of the common reason

underlying why engineers find projects difficult[35]. The study investigated how engineers resolve their concerns with difficult projects, resulting in an integrated theory of coping processes, which contributes to existing studies on the stress of professional engineers. Considerable emotional involvement with projects was evident in the data, and this could be explained by understanding the coping processes. Thus the present study contributes to the substantive area by both revealing this emotional involvement and accounting for its formation. The importance of emotions is supported from the present study by the complex influences of emotion on the ways engineers coped. Although not central to the main thread of the thesis, investigation of relationship enhancing communication also contributes to existing research. These contributions will now be discussed.

9.3.1 Interpretive study of the relationships between civil engineers and their projects

The present study is the first interpretive study to focus on the experiences of, and relationships between, engineers and their projects. The importance of individual projects to engineers was evident in the work of Fletcher (1999), who identified the process of "preserving" (the project), however, the focus of her study was on the ways women engineers related to others at work. Other significant explorative interpretive studies of practicing engineers have focused on the experience of women engineers (Ambrose, Lazarus, and Nair, 1998; Miller, 1998), crises in construction management (Loosemore, 1997), how technical managers sustain commitment (Starling, 1991) and the stressful incidents of young engineers (Keenan and Newton, 1985).

The present study is also the first interpretive study to focus on the experiences of civil engineers. Rather than working in an industrial plant, as many engineers do, civil engineers usually work for consultancies, councils or contractors. This means that they form contacts with many different people and organisations. This may be why relationship enhancing communication arose as an important type of competence in the present study. The public nature of many civil engineering projects contributes to the extent to which the public may imply engineers to be incompetent. This was a

[35] The common underlying concern is discussed in Chapter Three and summarised in Section 9.2.

source of considerable frustration for engineers in the present study. A third reason why it has been beneficial to study civil engineers is that most of their projects are located in specific physical sites and communities. The specific nature of each project can present engineers with problems that challenge their competence, thus contributing to the extent to which they work with borderline competence.

9.3.2 Understanding why projects can be difficult

Keenan and Newton (1985) undertook a study of the reasons why graduate engineers found some incidents stressful. The present study adds to their findings by presenting an understanding of the reasons why civil engineers find projects, rather than specific incidents, difficult. It was found that a wide range of conditions could contribute to the level of project difficulty (these were presented in Chapter Three). The important contribution, however, from the present study is the identification of the common underlying concern for competence that accounts for the perceived difficulty of projects (see also Chapter Three), and further, an understanding of how engineers process this concern. This concern with competence supports Keenan and Newton's (1985) finding that work that engineers perceive as too hard or too easy contributes to engineers' stress.

9.3.3 Study of coping processes

A number of researchers have studied stress in professional engineers (see for example Newton and Keenan, 1987; Saleh and Desai, 1990; Sales, Lavanoni, and Saleh, 1984; Sharma and Acharya, 1991). These studies have tended to focus on stable coping styles or personality traits, and general measures of stress and anxiety. The study by Newton and Keenan (1985), discussed above, is an exception to this because they investigated stress due to specific stressful incidents. Latack and Havlovic (1992) argue that focusing research on coping behaviours and processes rather than stable coping styles or personality traits is important as behaviours and processes are more amenable to stress management intervention and training (p.483). My study contributes to the existing research because it provides a conceptual framework of the coping processes engineers use to deal with stress that results from project involvement.

It is well established in the literature that people cognitively assess their performance. This is described by concepts such as self-assessment (Trope, 1986), self-verification (Swann, 1990) self-evaluation (Higgins, Strauman, and Klein, 1986), and self-awareness (Baumeister, 1998). The present study highlights the importance that individual projects can have to engineers' perceptions of their competence.

Some research has already been done on job involvement of engineers (Keller, 1997; Sharma and Sharma, 1978a; Sharma and Sharma 1978b; McKelvey and Sekaran, 1977). In the present study investigation of the processes by which engineers develop a sense of ownership of projects represents a focus on short term, project specific involvement. The processes identified in this study may contribute to the understanding of how the extent of engineers' job involvement (long term involvement in their work) may develop.

In the present study an important coping strategy engineers used was judging that factors beyond their full control explained poor project and/or personal performance (i.e. external attribution). This finding contributes to an existing debate on personality traits and coping and is discussed next.

9.3.4 Debate on the locus of control versus appropriate coping

Individuals have generalised, stable dispositional beliefs about their ability to control their environment, known as the 'Locus of Control' (Lazarus and Folkman, 1984). People with an 'internal' locus of control believe that events are contingent on their behaviour (such as the skill recognition interpretive style that was discussed in Chapter Six), while an 'external' locus of control involves a belief that events are contingent upon luck, chance, fate or powerful others rather than their own action (Lazarus and Folkman, 1984, p.66). People with internal control beliefs use more problem-focused coping and less emotion-focused coping methods (such as external attribution) than people with external control beliefs, presumably because they believe that their own efforts will be effective in altering the outcome of a stressful situation (Terry, Tonge, and Callan, 1995, p.3). A number of studies have found that avoidance-coping (emotion-focused coping) is associated with psychological distress (Sharma and Acharya, 1991, p.113), suggesting that it is beneficial to have an internal

locus of control. Such a benefit of having an internal locus of control was found in the study by Saleh and Desai (1990) where engineers with an internal locus of control were more satisfied and experienced less stress than engineers with an external locus of control.

Some authors have, however, argued that problem-focused coping is not always the most appropriate method of coping, particularly when the individual does not have a high level of control over the situation (Terry et al., 1995, p.21). They argue that a wide repertoire of both problem-focused and emotion-focused coping is appropriate (Hurrell, 1989, p.37). More specifically, Terry et al. (1995) recommend that employees should be encouraged to disassociate themselves from uncontrollable stressors, particularly people with internal control beliefs who may have increased job dissatisfaction due to their unwillingness to minimise the importance of uncontrollable stressors (p.19). Lazarus and Folkman (1984) emphasise the importance of distinguishing between cognitive appraisals of specific situations, and general beliefs, that is dispositions such as the locus of control (p.69). Therefore, while an internal locus of control and problem-focused coping may be generally advantageous to an engineer's wellbeing, it is nevertheless important to have realistic appraisal of, and appropriate coping for, specific situations.

The present study found that engineers often perceived that they had only partial, if any, control over the factors that influence the performance of the project, and yet the competence of engineers is based in large part on the performance of their projects. This emphasises the importance of realistically analysing the extent to which different factors influence the performance of a project. From the perspective of engineers in this study there appears to be a strong tendency for others to assume that the engineers do, or should, have more control of their projects than is actually the case. Thus when projects perform poorly engineers can feel that this reflects on their competence, which can contribute to frustration and loss of esteem. The present study thus supports the importance of coping methods that are appropriate to specific situations, which may include emotion-focused coping (such as external attribution, or chilling out) to the ability to get through difficult projects.

The "have I done a good job?" and "taking ownership" processes identified in the present study, are important to understanding the emotional involvement of engineers in their projects.

9.3.5 Emotional involvement

Despite the intensity of emotional involvement resulting from project involvement that was evident in the present study, qualitative studies of engineers have not focused on this topic. Further, the important role that emotion can play has not been explicitly included in texts on project management (see for example Francks, Testa, and Winegardner, 1992; Meredith and Mantel, 1995; Harrison, 1985; Saeed and Johnson, 1995). The present study helps to reveal this emotional intensity and to account for its development. The importance of emotional involvement is emphasised by its positive and negative effects on the ability of engineers to get through project tasks. Exposing this emotional intensity may help engineers to feel reassured that others have had similar experiences. Identifying the processes involved in the formation of emotional involvement in projects may help engineers and engineering supervisors to improve the emotional experiences of project involvement.

9.3.6 Relationship enhancing communication

Most research on relational enhancement focuses on romantic relationships and little is known about enhancement in other types of relationships (Wilmot, 1995, p.77). In the present study the concept of 'relationship enhancing communication' was recognised to be applicable to the intentional effort of engineers to enhance relations with other people and organisations that were involved in their projects, or possible future projects. Fletcher (1999) and Irwin, More, and McGrath (1998) also identified relationship management techniques used by engineers that can be viewed as relationship enhancing communication. Many of the techniques for enhancing relations identified in the present study were similar to those identified in these previous studies. The main contribution of the present study is the identification of conditions that influence when engineers do and when they do not put effort into enhancing relationships.

In conclusion, the present study contributes to existing research by providing an interpretive understanding of the experiences of engineers involved in difficult projects. As such it highlights the importance of the role of emotion and the social and psychological processes involved in getting through projects. The ways in which engineering practices can best support engineers with these processes, in order to help them get through difficult projects will be discussed next.

9.4 Implications for engineering practice

An important theme of the present study is that the extent of connection engineers' perceive between their projects and their competence, and the consequences this might have (for both themselves and others), results in emotions that influence their ability to get through their projects. By being aware of the processes that are involved, I propose that engineers could more easily cope with difficult projects and their supervisors could better support them to cope. Methods of supporting engineers that I propose include providing engineers with projects of appropriate difficulty, facilitating access to social support and experts, facilitating realistic attribution of performance and appropriate ownership, and facilitating the reading of qualitative research about engineers. Fortunately, many supervisors do already attempt to support engineers in many of these ways. The present study should affirm their beliefs of the importance of these attempts and encourage their continuation.

9.4.1 Provide projects of appropriate difficulty

Engineers cope with, and gain satisfaction from projects that are of appropriate difficulty. That is, when projects contribute to them gaining competence, but are not too challenging. While engineering supervisors may be able to control this to an extent, this will not always be the case. For example, it is the nature of some projects that they are particularly hard or easy, but the reality is that someone has to work on those projects. In addition, the difficulty of projects is often not known in advance. Engineers can influence their chances of obtaining projects of appropriate difficulty by expressing their desires for future projects to management, and explaining to their supervisors when they think they have a project that is too hard. If engineers continue to receive projects of inappropriate difficulty then it may be appropriate for them to consider changing employers. Young engineers who changed employers had a

significant decrease in work that was too easy and reported less job dissatisfaction in comparison to engineers who did not change employers (Newton and Keenan, 1990, p.119). By changing employers these engineers were able to advance their competence frontiers more rapidly.

9.4.2 Facilitate access to social support and experts

Access to experts and social networks of support were very important to engineers' abilities to cope both practically and psychologically with difficult projects. The organisational culture and engineers' supervisors play important roles in providing them with good support situations. Engineering employers can facilitate engineers' access to expertise required for their projects, and can help them to develop good relationships with people or organisations that will facilitate their future development. Supervisors may also be able to facilitate engineers' ability to manage stress by helping them to do a good job. Formal mentoring programmes could be very beneficial to young engineers, particularly as good mentors are likely to be able to help them to develop realistic conceptual models of the factors that influence project performance, the importance of which is emphasised in the following section. Family and colleagues who are external to the organisation often play an important role in helping engineers to get through difficult projects. There may be scope for organisations to facilitate the support that these people provide to engineers.

Engineers can, themselves, facilitate good social support through maintaining connections with colleagues and using the techniques of relationship enhancing communication that were discussed in Chapter Five. Engineers can also attempt to again access to experts when appropriate by making it clear to their management why the access to experts is important.

9.4.3 Support realistic attribution of performance

Supervisors have important roles in helping engineers to establish realistic expectations and in discussing the factors that influence project difficulty. Supervisors could make reflective meetings part of their standard practice, with an emphasis on developing proactive plans for the future. If supervisors have expectations that are too high, or if they assume that engineers have a higher level of control over their projects than is actually the case, then the engineers are likely to

suffer from anxiety. So, if a supervisor places high expectations on engineers, this should be supported with a high level of support. This should include not only the provision of access to technical expertise, but also support for coping with stress and for realistic attribution of the causes of performance. A high level of support does not necessarily mean that engineers should be closely supervised, for some engineers crave autonomy, but access to support should be available if required. For example, Sales et al. (1984) found intrinsically oriented (internally motivated) employees are more satisfied under a general supervision style, while extrinsically oriented (externally motivated) employees have greater satisfaction under a close supervision style. This suggests that how closely employees are guided and supported should depend on the individual's orientation.

The present study suggests that there is scope for engineering employers to have more open discussion on the many factors that influence project performance, with an emphasis on the organisation and its individuals learning how to tackle similar projects, rather than attributing or implying incompetence. Ideally this would reduce the amount of stress felt by engineers. Such a focus could have the opposite effect, however, if engineers anticipate more risk of incompetence being exposed through greater scrutiny of their projects. The engineering community needs to recognise that many factors can influence project performance. While it can be desirable to learn about those factors and attempt to influence them, it must be acknowledged that many of the factors will remain beyond the control of engineers.

9.4.4 Facilitate appropriate ownership

Supervisors can help engineers to cope by helping them to develop an appropriate level of ownership of their projects. Sometimes engineers will have a very low sense of ownership because they do not see the project as being important to them. In such cases it may be beneficial to the organisation and to the engineer to increase the engineer's sense of ownership. Methods for facilitating an increase in ownership involve negotiating ownership with the engineer through consequence appraisal. For example, explaining the importance of the engineer's role may increase an engineer's level of ownership for a mundane or easy project. Extending engineers' influence

and responsibility over their projects so they that feel that their projects are more important to their competence frontiers can also increase ownership.

The focus of the present study, however, was on projects where engineers were likely to have a high sense of ownership, which could contribute to them procrastinating or suffering from significant stress. In these cases of over-involvement, supervisors may be able to help engineers to cope by facilitating a reduction in their sense of ownership. It is important to recognise that the extent of ownership felt by engineers may not be commensurate with their formal responsibility. Therefore supervisors should attempt to understand the extent of ownership that engineers have for their projects. This may be achieved by asking engineers outright about how they feel about their projects. The level of importance of projects to the individual goals or values of engineers can influence their concern with their competence and hence their extent of ownership. Finding out about these goals may help engineering supervisors to assess or even predict each engineer's extent of ownership of particular projects. In addition, by being aware of indications of stress such as emotional expression, ill health or procrastination, engineers and their supervisors can attempt to recognise when the sense of ownership is getting too high.

What can be done when an engineer's sense of ownership is too high? First, the sense of ownership is influenced by engineers' perceptions of how they and other people assess their competence, and this topic could be discussed with the engineer (as discussed in section 9.4.3 above). Secondly, the engineer may need help in altering the potential consequences of the project for himself or herself or others. Altering the consequences may require improving access to experts or allocating more time to the project, getting other people to increase their ownership (so the engineer feels able to lower his or her own ownership of the project), or making other people aware of the lack of connection between the project performance and the engineer's competence. In some cases it may be that the engineer just needs reassuring that the consequences will not be as bad as the engineer fears.

An engineer's sense of ownership may be entirely appropriate to the circumstances and the potential consequences of the project cannot be altered. In these cases all the engineer's supervisor may be able to do is to help the engineer to cope with the stress. Some of the ways that engineers cope with stress were presented in Chapter Eight. Many of these ways of coping with stress involve having good social support from other people at work, other colleagues who work elsewhere, or spouses. So having a supportive work culture and encouraging engineers to develop social connections with other colleagues may be helpful.

9.4.5 Encourage reading of qualitative research of engineers

It is the nature of qualitative research that reading the write-up of the research is usually helpful to people in the area of study. Just knowing that other people have had similar experiences can be reassuring. Thus reading about how engineers cope, in the present study and from other qualitative research of engineers, is likely to help them to cope. For example, the present study has identified many coping skills that engineers use, and knowledge of these may help engineers to use them. I am sure that I would be better able to cope with difficult projects as a result of undertaking this study, because of what I have learnt from the engineers I interviewed, and as a result of the conceptualisation of the data with my associated learning about social-psychological theory. I therefore recommend that employers, professional institutes and educators encourage engineers and engineering students to read qualitative research about engineers. For example, such studies could be incorporated in project management texts and teaching. Further qualitative research of the experiences of engineers would contribute to this resource (see section 9.5).

In conclusion, employers/supervisors can help engineers by providing them with projects of suitable difficulty. They can help engineers to cope practically with difficult projects through facilitating access to adequate resources. They can discuss, with an engineer, the perceptions of performance expectations, the factors that influence project performance and the consequences of the project for the engineer and others, and attempt to change the engineer's perceptions if this is appropriate. Employers/supervisors may also be able to help engineers to cope with high stress levels by being part of, or facilitating appropriate social support for the engineer. It is

now appropriate to consider the future research opportunities indicated by the present study.

9.5 Future research

In the present study engineers' competence frontiers were only studied in relation to their involvement in projects. There is considerable scope to research other processes associated with engineers' competence frontiers. For example, engineers emphasised the importance of difficult projects to developing their competence frontiers. Future research could investigate the roles that involvement in difficult projects, and the associated advancement in their competence frontiers, has on their career development. The present study identified the processes of engineers' competence frontiers that enable them to cope with difficult projects, and many of the associated skills that engineers use for coping. Future research could focus on identifying how engineers actually develop these competencies and the factors that influence this development. The ways in which supervisors manage engineers could also be a factor that contributes significantly to the development of engineers' coping competencies, and it would be interesting to know what they do to help engineers to cope. The current approach to educating engineers has some characteristics that may hinder the ability of engineers to cope in practice; this topic also warrants further investigation. These potential research topics will now be discussed in more detail.

9.5.1 How does involvement in difficult projects affect career development?

Engineers in the present study discussed the importance of being involved in difficult projects to both gaining and demonstrating competence, saying that this then influenced what projects and jobs they obtained in the future. It appears that a positive experience with a difficult project contributes to engineers' confidence and to their subsequent desire and opportunities to be involved in other difficult projects. On these subsequent projects engineers may then develop even more confidence and competence. In some situations, however, engineers can feel a loss of confidence through involvement in a difficult project, or dislike the level of stress they feel, and these factors can then influence the types of projects and jobs they take on. Thus experiences of being involved in difficult projects can significantly affect the

development of competence in engineers and their career paths. Future research should focus on how the subjective experience of being involved in difficult projects and the associated development of competence, affect the career development of engineers. The present study has identified coping skills that engineers use to get through difficult projects, but did not focus on how engineers actually developed these skills.

9.5.2 How do engineers develop coping skills?

While engineers in the present study emphasised that they gained competence through involvement in difficult projects, the actual mechanisms by which they gained competence were not identified. Further, some engineers said that they gained skills for coping through processes like maturity, general life experiences or "osmosis". If we could better understand how engineers actually develop coping skills, we may be able to help young engineers to gain these skills. In addition to understanding the mechanisms of developing coping skills, understanding the factors that influence their development could help engineers acquire these skills. Supervisors are likely to be important to the development of engineers' coping skills and this topic deserves further investigation.

9.5.3 How do engineering supervisors manage their staff?

There were indications in the present study that engineers play deliberate and important roles in helping, or hindering, other engineers to cope. Qualitative research focusing on how supervisors go about managing engineers is likely to be a useful and exciting topic of research that would build on this study. Further more, to what extent do the coping skills of supervisors affect their ability to help their staff gain these skills? Are supervisors who are good at coping with difficult projects the ones who best help engineers to cope? Or, because the subjective experiences of engineers is important to coping, is it the supervisors who didn't cope well initially, but now cope better, who are most effective in helping engineers to cope? The formative experiences of engineering education may also significantly influence the ability of engineers to cope with difficult projects.

9.5.4 How does engineering education influence how graduates' cope?

A study of students at the School of Civil Engineering, Queensland University of Technology found that assessment driven learning was widespread, with students adopting a atomistic/surface approach to learning (Franz, Ferreida, and Thambiratnam, 1997). Similarly, in a School of Engineering in New Zealand, Godfrey and Parker (1998) found that "students value the acquisition of grades, whether the target is just passing, or gaining honours. The value of this goal takes precedence over a deep understanding of learning..." (p.15). The high connection between performance and self-esteem that is encouraged by an emphasis on grades, may contribute to engineering graduates having high levels of stress when they think their performance is poor in engineering practice. It is appropriate therefore to suggest that future research should address how the culture of engineering education affects the ability of graduates to cope in practice.

Another problem with a strong emphasis on academic grades is that grades provide students with explicit feedback on their performance, so students may not develop the skills of realistically assessing for themselves what factors contribute to performance during their education. The contrast between the relatively objective indications of performance provided by grades at university, and the more subjective processes of assessing performance in the workforce, may contribute to graduate engineers having high stress levels and loss of esteem when they enter the workforce. Kohne and Spiegel (1988) argue that engineering students need to develop skills in evaluating the effort and progress of an engineer and in effectively communicating the results of this evaluation (p.18). They have developed a course where students undertake design projects and develop evaluation skills in the process. An interesting research task would be to investigate whether such courses would improve the ability of graduates to cope in engineering practice.

9.6 Final word: a personal reflection

This thesis was motivated by my experience of being involved in a difficult project as a graduate engineer. I am delighted with my choice of grounded theory as the research method as I have been astounded by how much I have learnt about the experience of being a civil engineer as a result. In fact many grounded theory

researchers are similarly motivated to study an area of deep 'life cycle interest' (Glaser, 1998, p.49). Glaser describes the research of the grounded theorist studying a life cycle interest, which reflects my own experience, as follows:

> His (sic) job is to find out what is going on by looking at the patterns that emerge from many people. Thus his own particular problem embedded in an interest gets transcended to a grounded theory, which can then be brought back to help him understand the area of interest and his particular problem. (Glaser, 1998, p.49).

I found that exploring the experiences of other engineers enabled me to develop a far broader contextual understanding of my work experience as a graduate engineer. Upon reflection, the three processes involved in managing the competence frontier were occurring during my work experience, and do account for much of my behaviour and feelings at the time. My only regret is that I did not have knowledge of these processes before I entered the work force! My hope is that this thesis will contribute to the well-being of engineers, helping them to enjoy their work, to remain in the engineering profession and to contribute to the development of projects that improve our quality of life, including the enhancement and protection of our physical and social environments.

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Appendix A: Example of a consent form

How do civil engineers deal with difficult projects?

Participant's Consent Form

I have read and understand the information sheet on the above named research project.

I agree to participate in the project, and I consent to the publication of the findings of the project on the understanding that the confidentiality of the participants will be preserved, including any other identifying details such as the names of any engineering projects discussed during the research.

I also understand that I may at any time withdraw from the research project and that if I do so then any information I have provided will also be withdrawn.

Signature_____ Date_____

Name _____

Appendix B
Information sheets for interviewees

Approaches to ill-defined projects in Civil Engineering

Research Project Information Sheet Nov 1998

This research project is a doctoral study being undertaken by Anna Walls at the University of Canterbury, with the support of Professor David Elms, Civil Engineering Department; Dr Anne Ditcher, Mechanical Engineering Department; and Dr Ian Brooks, Department of Management.

Anna Walls has a BE(Civil) from University of Canterbury. She worked for two years with a consulting engineering company. During this work experience Anna became interested in projects and problems that can be described as "ill-defined". That is, the projects or parts of projects where a prescriptive ("cook-book") code or procedure is not followed. Engineers find working with such projects both challenging, frustrating and enjoyable. The Resource Management Act and the Alternative Solution under the Building Act have probably increased the ill-defined nature of many civil engineering projects in New Zealand. Literature searching has revealed no empirical studies that investigate how civil engineers deal with such projects. Many engineers and engineering educators perceive a considerable gulf between engineering education and what actually goes on in engineering practice. Aspects of this gulf include the difference between: a) the basic sciences/mathematics emphasis in engineering education and the approaches used in engineering practice, b) the emphasis on prescriptive codes in civil engineering education, to the detriment of the areas not covered by prescriptive codes, and c) giving students well-defined problems which often have only one correct solution, compared to the ill-defined problem situations encountered by practicing engineers. The lack of empirical research on the work of engineers has allowed the continued existence of this gulf.

This research will develop a descriptive, explanatory theory on how civil engineers approach ill-defined projects or problems in their work. The research will use a qualitative research methodology called Grounded Theory. With Grounded Theory the researcher explores an area of interest, without preformed hypotheses, and inductively derives the theory. This research project will develop theory from information gathered mainly through interviews, with the support of engineering project documentation, where necessary. The theory will be strengthened by relating it to literature on approaches used by people in other (non civil-engineering) situations.

Interviews will be based on exploring the engineer's involvement in one or more engineering projects, or a field of engineering. Interviews will last about an hour. The interviews will be audio-taped. The tapes may be transcribed to aid the research analysis. The transcriptions will use pseudonyms for the interviewee and any other identifying features such as the name of any engineering project or other people involved in the engineering project.

The results of the research are likely to be published. Whilst quotes may be used to illustrate points, the participants and projects involved in the research will remain completely confidential. The details of specific techniques or technical knowledge are not the focus of the research. There may be instances where such information is useful in illustrating a point, however this would not be published unless specific permission is given by the engineer and his/her employer. Participants may, at any time, withdraw from the research including the withdrawal of any information provided. This project has been reviewed and approved by the University of Canterbury Human Ethics Committee.

This research project is an important landmark study that is expected to be of significant use to both practicing civil engineers, and the education of civil engineers. I hope you will be willing to partake in the research. If you have any queries please contact myself or Prof. Elms.

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How do engineers deal with difficult projects?

Research project information sheet

Nov 1999

This research project is a doctoral study being undertaken by Anna Walls at the University of Canterbury, with the support of Dr Ian Brooks, Department of Management and Dr Anne Ditcher, Mechanical Engineering Department. Anna is currently part way through her data gathering and analysis.

Anna Walls has a BE(Civil) from University of Canterbury. She worked for two years with a consulting engineering company. One of the projects Anna worked on during this time was unusual and involved a number of difficulties. This initiated Anna's interest in how engineers approach and deal with difficult projects.

This research is developing a descriptive, explanatory theory on how civil engineers deal with difficult projects in their work. The research is undertaken using a qualitative research methodology called Grounded Theory. With Grounded Theory the researcher explores an area of interest, without preformed hypotheses, and inductively derives the theory. Data for the research is gathered mainly through interviews, with some use of documentation from an engineering project. The theory is being strengthened by relating it to literature on approaches used by people in other (non civil-engineering) situations.

Interviews are based on discussing the engineer's involvement in projects that the engineer found difficult and/or challenging. Topics likely to be investigated during an interview include: the nature of the difficulties faced by the engineer, strategies the engineer uses in tackling the project, emotions that arise as a result of involvement with a difficult project, and the influence of difficult projects on the engineer's level of experience and career. Interviews last up to three-quarters of an hour. The interviews are audio-taped. The tapes are being transcribed to aid the research analysis. The transcriptions use pseudonyms for the interviewee and any other identifying features such as the name of any engineering project or other people involved in the engineering project.

The results of the research are likely to be published. While quotes may be used to illustrate points, the participants and projects involved in the research will remain completely confidential. The details of specific techniques or technical knowledge are not the focus of the research. There may be instances where such information is useful in illustrating a point, however this would not be published unless specific permission is given by the engineer and his/her employer. Participants may, at any time, withdraw from the research including the withdrawal of any information provided. This project has been reviewed and approved by the University of Canterbury Human Ethics Committee.

This research project is an important landmark study that is expected to be of significant use to both practicing civil engineers, and the education of civil engineers. I hope you will be willing to partake in the research. If you have any queries please feel free to contact Dr Anne Ditcher or myself.

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How do civil engineers cope with difficult projects?

Research project information Sheet

July 2001

This research project is a doctoral study being undertaken by Anna Walls at the University of Canterbury, with the supervision of Dr Ian Brooks, Department of Management and Dr Anne Ditcher, Mechanical Engineering Department. The study is currently near completion, however addition data on some aspects of the thesis is being sort.

Anna has a BE(Civil) from University of Canterbury. She worked for two years with a consulting engineering company. One of the projects Anna worked on during this time was unusual and involved a number of difficulties. This initiated Anna's interest in how engineers approach and cope with difficult projects.

This research is developing a descriptive, explanatory theory on how civil engineers cope with difficult projects in their work. The research is undertaken using a qualitative research methodology called Grounded Theory. With Grounded Theory the researcher explores an area of interest, without performed hypotheses, and inductively derives the theory. Data for the research is gathered mainly through interviews, with some use of documentation from an engineering project. The interpretation of the data is aided by the use of existing social-psychological theory.

Topics likely to be investigated during the interview include: the nature and development of taking a sense of ownership over projects, emotions that arise as a result of involvement with a difficult project, and when and how relationship enhancing communication is used. Interviews last up to three-quarters of an hour and may be audio-taped and transcribed. .

The results of the research are likely to be published. While quotes may be used to illustrate points, every attempt is made to remove from quotes any information that could reveal the identity of the engineer or people or projects discussed by the engineer. Participants may, at any time, withdraw from the research including the withdrawal of any information provided. This project has been reviewed and approved by the University of Canterbury Human Ethics Committee.

This research project is an important landmark study that is expected to be of significant use to engineers. I hope you will be willing to partake in the research. If you have any queries please feel free to contact Dr Anne Ditcher or myself.

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